AERONAUTICAL ENGINEERING REVIEW

MARCH 1951

NINETEENTH ANNUAL MEETING ISSUE

Ideas you can use!

These diagrams show a few of the ways in which Sylphon bellows assemblies are used—where there's a design problem involving control of temperatures or pressures. They open and close valves, dampers, etc., absorb expansion, provide packless construction, have many more uses.

We've developed bellows assemblies that are used in practically every industry. It's a specialty with us—has been for half-a-century. Skilled craftsmen and complete facilities produce *exactly* what you require, no matter how complex an assembly you need.

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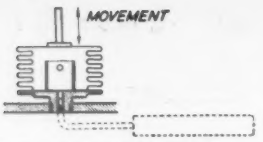

Fig. 1 Thermostatic Motor—This type of assembly is widely used in temperature regulators, etc., where a thermostatic charge is confined in the bellows and where a valve, switch, damper, etc. is to be operated in response to temperature changes.

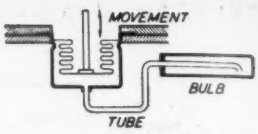

Fig. 2 Thermostatic Motor—This assembly is used where it is desirable to have the thermostatic charge confined outside the bellows and within a cup. May be used with or without remote bulb shown.

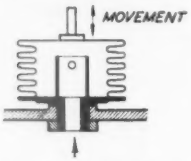

Fig. 3 Pressure Motor—Bellows assemblies are often employed to convert pressure effects into controlled movement. Fig. 3 shows such an assembly where the pressure is applied inside the bellows.

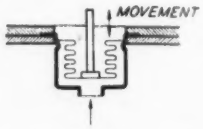

Fig. 4 Pressure Motor—This assembly differs from Fig. 3 in that the pressure is applied outside the bellows and within a cup.

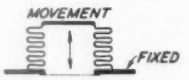

Fig. 5 Expansion Chamber—This type of assembly is employed to absorb thermal or pressure expansion. With suitable heads, it would be used to serve as a reservoir for a liquid or gas. Example: Oil reservoir for electrical cable joint.

Fig. 6 Expansion Joint—Packless and leakless construction for expansion joints used to absorb thermal expansion of pipe lines carrying steam, water, etc. May be used to absorb vibration and provide flexible connection for other applications.

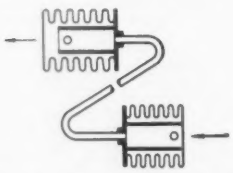

Fig. 7 Motion Transmission—Two bellows assemblies joined by a tube for hydraulic transmission of motion or power. Motive force applied may be either thermostatic or mechanical.

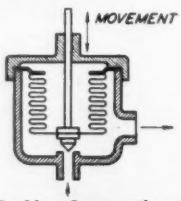

Fig. 8 Packless Construction—Illustrating packless valve construction. Same principle used to seal stem movement or adjustment in many types of apparatus.

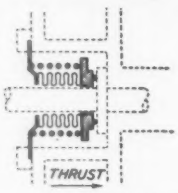

Fig. 9 Shaft Seal—Widely used for refrigeration compressors to prevent leakage around revolving shaft. Spring pressure holds nose of seal against shoulder on shaft. Another type used rotates with shaft and seals against stationary plate.

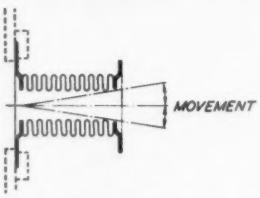

Fig. 10 Flexible Joint—Providing a means to seal a flexible joint or mechanical movement of levers, linkage, etc., against leakage where the movement must be conveyed outside an enclosure. Example: Operating stem of float switches, etc.

TEMPERATURE CONTROLS

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Robertshaw-Fulton CONTROLS COMPANY

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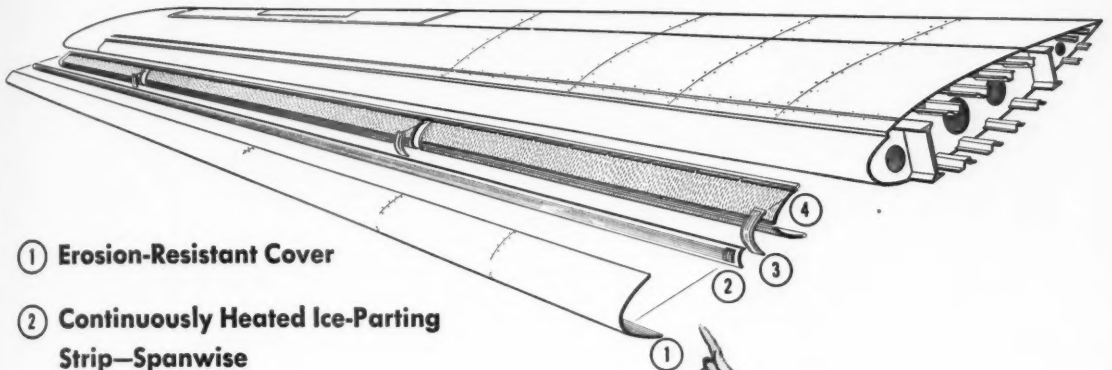
BRIDGEPORT THERMOSTAT *DIVISION*
Bridgeport 1, Conn.

TYPICAL DIAGRAM OF GOODYEAR ELECTRO-THERMAL ICEGUARD



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2. Continuously Heated Ice-Parting Strip—Spanwise
3. Continuously Heated Parting Strip—Chordwise
4. Cyclic Heated Ice-Shedding Area

New "hot rubber" Iceguards

eliminate icing hazards

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At last we can tell you about the Kidde high altitude compressor! After years of intensive testing, Kidde engineers have released it for aircraft installation.
Here's what it will do:
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With this Kidde compressor, pneumatics for aircraft use takes another step forward. No other power system is so light in weight or has its required medium so readily available.
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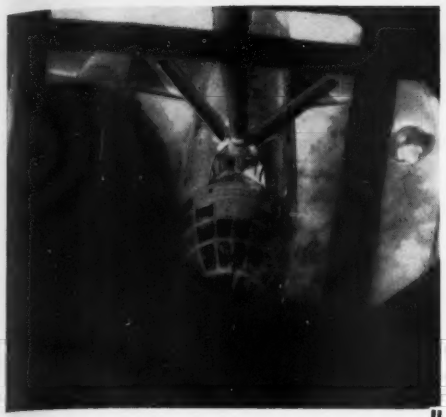

Cover—This photo, taken over the shoulder of the prone Flying Boom in a Boeing KC-97A Stratofreighter shows the new convertible aerial tanker as it refueled a Boeing B-50D Superfortress.

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AERONAUTICAL ENGINEERING REVIEW

Vol. 10 MARCH, 1951 No. 3

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"K"® Monel and "KR"® Monel are similar in composition and properties. "KR" Monel has better machinability and is recommended for parts requiring intricate machining.

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Tensile Properties: "K" Monel in the fully age-hardened condition has a minimum yield strength (0.2% offset) of 100,000 psi and a tensile strength of over 140,000 psi, with minimum elongations (in 2 in.) of 15% and 20% for cold-drawn and hot-rolled materials respectively. "KR" Monel, age-hardened, has a minimum yield strength (0.2% offset) of 90,000 psi with minimum elongation of 20% (in 2 in.) for as-rolled material.

Shear Strength: The shear strength of "K" Monel, as determined with .050-in. x .250-in. specimens subjected to double shear, is (full hard, age-hardened) 98,450 psi maximum, with 0.04 in. deflection. The shear strength of "K" Monel rivets, fully age-hardened, is 89,200 psi with ultimate tensile strength of 147,000 psi.

Spring Properties: "K" Monel wire can be cold-drawn and age-hardened to develop 160,000 to 200,000 psi tensile strength. The torsional proportional limit of cold-drawn, age-hardened wire is about 40% of the ultimate tensile strength.

Endurance Limit: In rotating beam tests of polished specimens at room temperature and 10,000 r.p.m., "K" Monel (cold-drawn, age-hardened) showed an endurance limit for 10^8 cycles of 41,000 to 59,000 psi.

Magnetic Characteristics: "K" and "KR" are non-magnetic under ordinary conditions and remain so at sub-zero temperatures.

Working Characteristics: Both "K" Monel and "KR" Monel may be hot-worked, forged, and cold-worked. "K" Monel may be readily machined in the annealed condition and may be considered commercially machinable at practical rates in other conditions with Brinell hardness of up to 275. "KR" Monel, because of higher carbon content and special thermal treatment, has better machinability than "K" Monel and is recommended for parts requiring more intricate machining. Because of greater hardness, both alloys will take a higher polish than Monel. Both may be joined by the usual welding, brazing, and soldering processes.

Corrosion Resistance: These alloys are highly resistant to attack by most commonly-encountered corrosives, including mineral and organic acids, alkalies, salts, potable and industrial waters, foods, organic compounds, and oxidizing atmospheres at normal and elevated temperatures.

Forms Produced: "K" Monel is supplied in most commonly-used mill forms—rods, hexagons, squares, flats, strip, sheet, seamless tubing, wire, welding materials—and in a variety of finishes and conditions. "KR" Monel is produced in rods, hexagons, squares, hot-rolled and cold-drawn.

Applications: Because these alloys retain their non-magnetic, corrosion-resistant, and high physical qualities at abnormal temperatures, they have been used to advantage in aviation instruments, roller chains for retractable landing gear, controls, springs and contact arms in electrical equipment, in stressed structural members and fastenings.

"K" MONEL
Effect of temperature on physical properties
(Age-hardened condition)

Test Temperature °F.	Yield Strength (0.20% offset) psi.	Tensile Strength psi.	Elongation in 2 in. per cent	Creep Strength (0.10% in 10,000 hr.) psi.	Hardness (Brinell)	Impact (Charpy) ft.-lb.
−300	160,200	202,000	27	...	...	...
−110	134,600	171,550	17.3	...	36 (Rock. C)	27
Room	111,000	160,000	23.5	...	331	27
200	108,000	150,000	23.5	...	...	...
400	103,000	149,000	24	...	...	...
600	105,000	146,000	23	...	...	...
750	...	...	...	67,000	...	...
800	105,000	124,000	8.5	48,000	302	...
1000	92,000	95,000	3	8,500	255	...
1100	...	...	...	...	229	...
1200	80,000	80,000	1.5	...	...	...
1400	30,000	45,000	8	...	...	...

FURTHER DATA AVAILABLE

A 23-page reference manual, *Engineering Properties of "K" Monel and "KR" Monel*, contains all essential engineering information on these alloys. It is available, free, for your files.

For help on specific metal problems involving corrosion, high temperatures, or fatigue, write directly to Inco's Technical Service, outlining your problems.

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I. A. S. News

A Record of People and Events of Interest to Institute Members

Notes on the Annual Meeting

Capacity Audience Attends Honors Night Dinner; Registration for Technical Sessions Largest in I.A.S. History

IN SPITE OF INCLEMENT WEATHER and railroad strikes, the Institute's Nineteenth Annual Meeting turned out to be the largest ever held. Approximately 1,100 people from all parts of the globe and representing every known field of the aeronautical sciences crowded into the Astor Ballroom for the Honors Night Dinner. Registration during the 4 days of Technical Sessions totaled more than 1,250—setting an all-time high for attendance at an I.A.S. meeting.

▸**Honors Night Dinner**—As the name implies, the Dinner is a prologue to the act of honoring those individuals who have made outstanding contributions to the advancement of the aeronautical sciences. Presentation of Institute Fellowships and the Jeffries, Losey, Reed, and Sperry awards was made on this occasion by J. H. ("Dutch") Kindelberger, outgoing I.A.S. President.

Every third year it becomes the Institute's privilege to have the Guggenheim Medal presented at its Honors Night Dinner. This year's recipient, Hugh L. Dryden, was the Institute's President in 1943. It was therefore appropriate that the presentation should be made by another I.A.S. Past-President—himself one-time winner of the Guggenheim Medal—James H. ("Jimmy") Doolittle.

Complete details about these various awards and fellowships may be found elsewhere in this issue.

▸**Dinner Speaker**—The Honorable James E. Webb, Under Secretary of State, delivered the main address of the evening. In it, he outlined the organizational setup and operation of the State Department and spoke briefly of some of the problems that confront it.

While space in this issue does not permit publication in full, a large portion of Mr. Webb's address will be found on page 30.

▸**Technical Sessions**—From the opening of the simultaneous meetings on Monday morning until the drop of the chairman's gavel late Thursday afternoon, the Technical Sessions were marked by good attendance, excellent papers, and even better discussions. Indicating the trend of the times were the full sessions on Hypersonics and Electronics, which made their appearance on an Institute national meeting program for the first time this year.

The late date of this year's meeting made it impossible to write up a full report of the Technical Sessions in time for this issue of the REVIEW. An article by "Steve" Zand, covering all sessions (except the ones on Electronics), will appear in the April issue.

Electronics plays such an important role in the design and operation of today's aircraft that the REVIEW is devoting its entire May issue to the treatment of this subject. In it will be carried all four of the full-length papers presented at the morning Electronic Session, plus discussions. The opinions of the experts, as expressed during the afternoon Electronics Symposium, are being scheduled as a feature article for the same issue.

▸**Annual Business Meeting**—In accordance with the Constitution and By-Laws, the Institute's Annual Business Meeting was held on the last Wednesday in January. Several hundred members were personally present and hundreds of others were represented by proxies.

The yearly reports of the President, Director, Secretary, and Treasurer were presented and approved. These, together with pictures of the newly elected Officers and Council for 1951, appear on the pages that follow.

Outgoing I.A.S. President J. H. ("Dutch") Kindelberger presenting 1950 Honorary Fellowship to Capt. Walter S. Diehl, U.S.N.

▸**Visit to Sands Point**—On Friday, following the close of the Technical Sessions, approximately 50 previously cleared representatives of I.A.S. Corporate Member companies made a day-long inspection tour of the Navy's Special Devices Center at Sands Point, L.I. Hosts on this occasion were Capt. John R. Ruhsenberger, U.S.N., Commanding Officer and Director of the Special Devices Center, and Rear Adm. Luis de Florez, U.S.N. (Ret.), a Fellow and present Council Member of the Institute, who was instrumental in establishing the Special Devices Center at Sands Point.

▸**Publication of Papers**—Many of the papers presented at the Annual Meeting were received in time to preprint them through the Sherman M. Fairchild Fund. Copies of those available in this form are listed on the Preprint Page of this issue (p. 43).

Preprints were not made of those manuscripts received at, or after, the meeting. Practically all of the papers presented at this meeting, however, are scheduled for publication in either the REVIEW or the JOURNAL at the earliest possible date.

W. A. S.

I.A.S. Honors and A

Honorary American Fellow

Captain Walter S. Diehl, U.S.N., Assistant for Research Liaison, Office of Assistant Chief, Bureau of Aeronautics, Department of the Navy

Born in Jonesboro, Tenn., on December 3, 1893, Captain Diehl received his B.S. degree in Electrical Engineering from the University of Tennessee in 1915. He took post-graduate work in aeronautical engineering at the Massachusetts Institute of Technology in 1918.

For the 2 years subsequent to his graduation from the University of Tennessee, he was employed as a Mechanical Engineer. In 1917, he enlisted in the U.S. Navy. After assignments to the aviation ground school at M.I.T. and to flight training at Pensacola, he was commissioned in 1918 as an Ensign. He was promoted through the ranks to Captaincy in 1942.

From 1918 to 1921, Captain Diehl was attached to the Naval Bureau of Construction and Repair. In 1921, he was transferred to the Navy's Bureau of Aeronautics where he has since remained. Much of his time has been consumed with the application of research findings to airplane design. Captain Diehl is considered a specialist on airplane design and research, as well as applied aerodynamics.

Awards for 1950

Honorary Foreign Fellow

Sir Henry Tizard, G.C.B., Chairman, Advisory Council on Scientific Policy, Ministry of Defence, England

Born August 25, 1885, Sir Henry was educated at the Westminister School and at Magdalen College, Oxford. He served with the Royal Air Force in World War I and later became Permanent Secretary for the Department of Scientific and Industrial Research. For a time, he was Rector of the Imperial College of Science and Technology and President of Magdalen College. Sir Henry is presently an Honorary Fellow of Oriel and Magdalen colleges, Oxford. From 1933 to 1943, he served as Chairman of the Aeronautical Research Committee and during the years 1941 to 1943 was a member of the Council of the Minister of Aircraft Production and an additional member of the Air Council. From 1934 to 1945, he was Development Commissioner.

Sir Henry has received the 1944 Albert Gold Medal from the Royal Society of Arts and the 1946 Gold Medal of the Franklin Society of Philadelphia.

Sir Henry is also a Fellow of The Royal Society, the Institute of Physics, and The Royal Aeronautical Society. He was President of the British Association for 1948 and he is a holder of the Air Force Cross. He has been a Trustee of the British Museum since 1937.

The John Jeffries Award

Brigadier General Otis O. Benson, Jr., U.S.A.F. (M.C.), Commandant, U.S.A.F. School of Aviation Medicine, Randolph A.F.B.

"For outstanding contributions to the advancement of aeronautics through medical research."

Honoring the memory of Dr. John Jeffries, an American physician who, with Blanchard, the French balloonist, made the first aerial voyage across the English Channel in 1785 and on a previous voyage made the earliest recorded scientific observation from the air, this award was established by the Institute in 1940 to give recognition to the importance to aviation of scientific endeavor in the field of medicine.

The Recipient: Born on September 14, 1902, in Minnesota, Brig. Gen. Otis O. Benson, Jr. received his B.A. degree from the University of Montana in 1924, his M.S. from the University of Iowa in 1925, and his M.D. from the University of Chicago in 1930. In 1932, he attended the School of Aviation Medicine; in 1933, the Army Medical School of Tropical and Military Medicine and the Medical Field Service School; in 1940, the Mayo Clinic and the Fatigue Laboratory, Harvard University, for postgraduate training; and in 1949, the National War College. He is a rated Flight Surgeon and an Aircraft Observer (Medical).

General Benson became the second Director of the Aero Medical Laboratory, which was begun about 15 years ago as a three-man unit in the Air Materiel Command. However, in due time, he obtained relative autonomy for it. Under his directorship, the physical plant was rebuilt into what is essentially its present form, and the functional pattern, the laboratories, and the research program that persisted throughout World War II were set up. He caused the enlarged Laboratory to be staffed with nationally known scientists, many of whom still remain there. In collaboration with the Mayo Clinic unit and others, he established the human centrifuge unit that perfected the anti-G suit. Before the advent of World War II, he recognized the need for a radically different method of administering oxygen to the air crew in high-altitude bombing. Accordingly, when he acquired the latest Luftwaffe O_2 equipment in England in 1941, he made certain changes in the apparatus and set the pattern for the ultimate development and use of the diluter-demand oxygen system.

General Benson fostered all types of physiological and biophysical studies to push the frontier of knowledge from 30,000 to 48,000 ft. It was he who initiated: (1) in association with Professor Houton of Harvard, the U.S.A.F. an-

(*Continued on page 11*)

The Robert M. Losey Award

Roscoe R. Braham, Jr., Research Associate, New Mexico School of Mines

"In recognition of outstanding contributions to the science of meteorology as applied to aeronautics."

Established in 1940, this award honors the memory of Capt. Robert Moffatt Losey, a member of the Institute and a meteorological officer of the Army Air Corps, who was killed at Dombas, Norway, April 21, 1940, while serving as an official observer for the U.S. Army. He was the first officer in the service of the United States to die in World War II.

The Recipient: Roscoe R. Braham, Jr., who celebrated his thirtieth birthday last January 3, was graduated in 1942 from Ohio University with a B.S. degree in geology. He received his M.S. degree in meteorology from the University of Chicago in June, 1948, and in August, 1950, was admitted as a Ph.D. candidate. He was born in Yates City, Ill.

Mr. Braham joined the U.S. Army Air Force in 1942 as an Aviation Cadet and was discharged in November, 1945, with the rank of Captain. At that time he held the dual rating of meteorologist and pilot of one-, two-, and four-engined aircraft.

In 1946, Mr. Braham was appointed Head, Gust Analysis Unit, Analysis Section, Thunderstorm Project, U.S. Weather Bureau, in charge of airplane data and flight interrogation in operations in Orlando, Fla. The following spring, he was promoted to Head, Analysis Section, and was stationed at Wilmington, Ohio. In June, 1949, he was a Research Associate at the University of Chicago's Department of Meteorology and studied the water and energy budgets of the thunderstorm under Dr. H. R. Byers, the Department's Chairman. In September of the next year, he joined the Research and Development Division of the New Mexico School of Mines, where he has continued research into meteorological physics under Dr. E. J. Workman, Director.

During the 1948–1949 analysis phase of Thunderstorm Project at Chicago, he served as Senior Analyst. In this capacity, he was directly responsible for the analysis of the data collected in such a way as to delineate the important and significant features that characterize the typical thunderstorm. This Thunderstorm Project, a joint undertaking by the Air Force, Navy, N.A.C.A., and Weather Bureau, has greatly advanced our knowledge of the mechanics and structure of the thunderstorm. Its results will play an important role in increasing the safety of air transportation.

(*Continued on page 11*)

The Sylvanus Albert Reed Award

Robert R. Gilruth, Chief, Pilotless Aircraft Research Division, Langley Aeronautical Laboratory, N.A.C.A.

"For the conception and development of new techniques for obtaining transonic and supersonic data using freely flying models."

The late Dr. S. A. Reed, designer of metal aircraft propellers and a Founder member of the Institute, made an endowment to the Institute in 1933 to provide an annual award with a certificate and honorarium of $25. This award is presented for a notable contribution to the aeronautical sciences resulting from experimental or theoretical investigations which have had a beneficial influence on the development of practical aeronautics. The recipient is chosen by ballot of the American Honorary Fellows and Fellows of the Institute, who now number more than 160 of this country's leading aeronautical scientists.

The Recipient: Robert R. Gilruth was born in Nashwauk, Minn., on October 8, 1913. Graduating from the University of Minnesota, he received his B.S. degree in Aeronautical Engineering in 1935 and his M.S. in Aeronautical Engineering in 1936.

As a Research Fellow at the University of Minnesota during the 1935–1936 scholastic year, Mr. Gilruth studied and experimented with "lighter than air" with particular reference to heating air. From January to December, 1936, he was a Stress Analyst of H. W. Barlow and Company and was concerned with stress analysis and airplane design. At Barlow he completed work on a monocoque hull for an amphibian; this analysis was later accepted for an A.T.C. He also completed a design for a racer that ultimately placed third in the 1937 Thompson Trophy Race of the National Air Races. During the same time he was with Barlow, he was also a Teaching Fellow at the University of Minnesota and became a laboratory instructor of airplane construction and inspection of airplane types. At the University he also assisted in instructing classes in airplane design. He joined the N.A.C.A. in January, 1937, and has remained on its staff since that time.

Mr. Gilruth has pioneered in the conception and development of successful experimental techniques for the investigation of aerodynamic phenomena at transonic and supersonic speeds. Free-flight research models propelled by rockets were utilized in his experiments. The intelligence gathered by these flights was transmitted to the ground by means of telemetering, radar, and other forms of communication. These techniques have been intensively applied to procure quantities of essential, but pre-

(*Continued on page 80*)

The Lawrence Sperry Award

Frank N. Piasecki, Chairman of the Board, Piasecki Helicopter Corporation

"For his outstanding contributions to the design and development of helicopters."

This award "for a notable contribution made by a young man to the advancement of aeronautics" was endowed in 1936 by the sister and brothers of the late Lawrence Sperry, pioneer aviator and inventor, who died in 1923 at the age of 31. It provides an annual certificate of citation and honorarium of $250 to the recipient selected by the Board of Award.

The Recipient: Born in Philadelphia, Pa., on October 24, 1919, Frank N. Piasecki began his engineering career at the Towne School, University of Pennsylvania, and was graduated in 1940 from the Guggenheim School of Aeronautics, New York University, with a B.S. in Aeronautical Engineering. At the Guggenheim School, he studied under the late Dr. Alexander Klemin, with special emphasis on rotary-wing aircraft.

Prior to his founding of the Piasecki Helicopter Corporation, Mr. Piasecki was employed as a Mechanic with Kellett Autogiro Corporation, a Designer with International Staple and Machinery Company, a Photogrammeter with Aero Service Corporation, an Aircraft Design Engineer with Platt-LePage Aircraft Company, and Chief Aerodynamicist with Edward G. Budd Company.

Mr. Piasecki, who pioneered in the development of the tandem-rotored helicopter, was the first man to qualify with the C.A.A. as a helicopter pilot before receiving a pilot's license on a conventional fixed-wing aircraft. At the age of 21, he organized a group of young engineers into the P-V Engineering Forum, Piasecki Helicopter Corporation's predecessor. Three years later, in 1943, this forum, under his direction, had completed the development and construction of the PV-2, a single-rotor helicopter weighing less than 1,000 lbs. The PV-2, test-flown by Mr. Piasecki, was the second American helicopter to be flown publicly.

In March, 1945, 13 months after receiving a Navy contract for transport-type rotary-wing aircraft, Mr. Piasecki test-flew the tandem-rotor PV-3 (HRP-1). The PV-3 was, at the time it went into production, the largest transport helicopter and the first transport helicopter of its type to fly successfully. Since that time, Mr. Piasecki has spearheaded further production of radical and revolutionary helicopter design that has resulted in the HRP-2 and the

(*Continued on page 80*)

I.A.S. Fellows For 1950

Milton B. Ames, Jr., Chief, Aerodynamics Research Branch, Headquarters, N.A.C.A.

Rear Admiral Calvin M. Bolster, U.S.N., Deputy and Assistant Chief, Office of Naval Research.

Edward F. Burton, Chief Engineer, Douglas Aircraft Company, Inc. (Santa Monica).

Lieutenant General Benjamin W. Chidlaw, U.S.A.F., Commanding General, Hdqs., A.M.C., Wright-Patterson Air Force Base.

Sherman M. Fairchild, Sherman Fairchild and Associates.

Robert L. Hall, Chief Engineer, Grumman Aircraft Engineering Corp.

George S. Schairer, Staff Engineer, Boeing Airplane Company.

1950 Guggenheim Medal Presented to Dr. Dryden

Dr. Hugh L. Dryden was presented with the Guggenheim Medal for 1950 at the I.A.S. Honors Night Dinner of the Nineteenth Annual Meeting. This Medal is given for notable achievements in the advancement of aeronautics.

The Guggenheim Medal was established in 1928 by the Daniel Guggenheim Fund for the Promotion of Aeronautics and is one of the nation's most coveted aviation awards. The recipient is selected each year by a Board of Awards consisting of representatives from the American Society of Mechanical Engineers, Institute of the Aeronautical Sciences, Society of Automotive Engineers, United Engineering Trustees, Inc., and previous American recipients of the medal. Formal presentation is made annually by one of the foregoing engineering societies.

Dr. Dryden's work has been largely concerned with wind pressure on structures, turbulence in wind tunnels, properties of airfoils at high speeds, and boundary-layer investigations. Dr. Dryden, himself, is said to consider his outstanding achievement to be research on turbulence and boundary layer. The author of various technical books, he has contributed numerous articles, reports, and bulletins to scientific journals. Since 1941, he has been the Editor of the JOURNAL OF THE AERONAUTICAL SCIENCES.

In 1938, Dr. Dryden delivered the Institute's annual Wright Brothers Lecture, his subject on this occasion being "Turbulence and Boundary Layer." Two years ago, in 1949, he presented the Thirty-Seventh Wilbur Wright Memorial Lecture before The Royal Aeronautical Society in London on "The Aeronautical Research Scene—Goals, Methods, and Accomplishments." Among other awards received by Dr. Dryden are: The Sylvanus Reed Award for 1940 from the I.A.S., the Presidential Certificate of Merit, and the Medal of Freedom, America's second highest decoration for civilians.

Lieutenant General James H. Doolittle, Chairman of the Guggenheim Medal Committee, makes the formal presentation to Dr. Dryden.

A native of Pocomoke City, Md., Dr. Dryden received his B.A. degree in 1916, his M.A. in 1918, and his Ph.D. (Physics) in 1919 from The Johns Hopkins University. Joining the National Bureau of Standards in 1918 as a Laboratory Assistant, he was advanced through the various grades to Head Physicist in 1938. He was made Chief of the Aerodynamics Section in 1920 and 14 years later was promoted to Chief of the Mechanics and Sound Division, N.B.S. He became the Bureau's Associate Director in 1946, and the following year he was appointed to his present position as Director of the N.A.C.A.

An Honorary Fellow and Past-President of the I.A.S., he is a Fellow of The Royal Aeronautical Society and the A.S.M.E. He is also a member of the American Physical Society and the Washington Academy of Sciences and is an Honorary Officer, Civil Division, Order of the British Empire.

The John Jeffries Award

(*Continued from page 8*)

thropological studies of the air-crew personnel to determine cockpit and other space requirements, clothing sizing, design of oxygen masks, etc.; (2) in association with Major Gen. M. C. Grow, the compilation of all German research work in aviation medicine during the years 1939–1945; (3) the studies leading to the establishment of standards for night vision in the Air Force; and (4) the physiological training program that is still active in giving altitude and "G" indoctrination to all air-crew personnel. He has continued the pioneer work of Major Gen. H. G. Armstrong on explosive decompression and on all aeromedical aspects of pressure-cabin problems. He has also encouraged and insisted upon the development of scientifically constructed and reproducible conditions.

The Robert M. Losey Award

(*Continued from page 8*)

Mr. Braham contributed much to the general understanding of the thunderstorm. Specifically, however, his principal contributions were: (1) the discovery of the nature of the life cycle of thunderstorm cells; (2) the discovery of the thermodynamic importance of the downdraft in thunderstorms; (3) the development of the method of correlating the complicated four-dimensional (x, y, z, t) picture of the thunderstorm as obtained by airplane flights and balloon, radar, and ground networks; (4) the relating of the manifestations of thunderstorms (such as excessive turbulence, hail, lightning, icing, etc.) to the thermodynamic processes and the stages in the life cycle; and (5) determining the expected turbulence risks in thunderstorm flying.

I.A.S. Officers for 1951

President
Lawrence B. Richardson
(Rear Adm., U.S.N., Ret.)
Director of Research and Development
Fairchild Engine and
Airplane Corporation

Vice-President
Raymond D. Kelly
Superintendent of Technical
Development
United Air Lines, Inc.

Vice-President
W. C. Rockefeller
Executive Assistant to the Chairman
of the Board
Consolidated Vultee Aircraft
Corporation

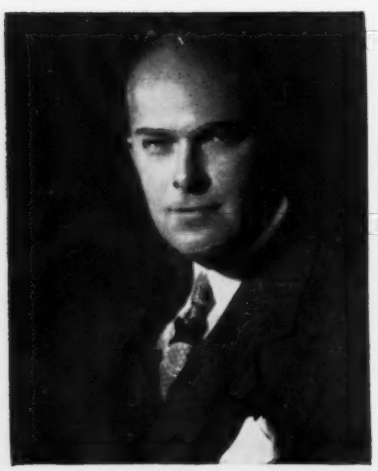
Staff Officers for 1951

S. Paul Johnston, *Director*

Robert R. Dexter, *Secretary*

Joseph J. Maitan, *Controller*

Vice-President
William T. Schwendler
Executive Vice-President
Grumman Aircraft Engineering Corp.



Vice-President
Edward C. Wells
Vice-President—Engineering
Boeing Airplane Company

Treasurer
E. E. Aldrin
Aviation Manager
Atlas Supply Company

Annual Business Meeting of the Institute

Reports of President, Treasurer, and Director

THE NINETEENTH ANNUAL MEETING of the members of the Institute was held at the Hotel Astor, New York, on January 31, 1951. The President-Elect, Lawrence B. Richardson, presided.

Professor Daniel Sayre, Teller, reported that he had received and counted 871 valid proxies for voting at the Annual Meeting—a quorum of the voting membership. Charles H. Colvin, Chairman of the Nominating Committee, placed in nomination the following members for election to vacancies on the Council: Lawrence B. Richardson, J. H. Kindelberger, Raymond D. Kelly, W. C. Rockefeller, William T. Schwendler, Edward C. Wells, and E. E. Aldrin, for a term of 1 year each; William A. M. Burden, Roger W. Kahn, Earl D. Osborn, Elmer A. Sperry, Jr., and E. S. Thompson, for a term of 3 years each; and the following area councilors for a term of 1 year each: Eastern Area—John W. Crowley, Jr., and Walter Tydon; Central Area—A. Francis Arcier and Vernon Outman; Western Area—Alfred S. Niles and L. Eugene Root. On motion duly made, seconded, and carried, they were unanimously elected. The following were nominated and elected in like manner to serve on the Nominating Committee for 1951: T. P. Wright, Chairman, Preston R. Bassett, Charles Froesch, Hall L. Hibbard, J. C. Hunsaker, Grover Loening, John K. Northrop, and Ernest G. Stout.

The Annual Reports of the President, Treasurer, and Director were read and approved. (See the following pages for the complete reports.)

The Secretary presented a list of honors conferred by the Institute in 1950 as follows:

The Thurman H. Bane Award to Col. George W. Goddard, Chief, Photographic Laboratory, Engineering Division, A.M.C.; The Octave Chanute Award to Comdr. Donald Bertram MacDiarmid, U.S.C.G., Commanding Officer, Coast Guard Air Station, San Diego, Calif.; The John Jeffries Award to Brig. Gen. Otis O. Benson, Jr., U.S.A.F. (M.C.), Commandant, U.S.A.F. School of Aviation Medicine, Randolph Air Force Base, Tex.; The Robert M. Losey Award to Roscoe R. Braham, Jr., Research Associate, New Mexico School of Mines, Socorro, N.M.; The Sylvanus Albert Reed Award to Robert R. Gilruth, Chief, Pilotless Aircraft Research Division, Langley Aeronautical Laboratory, N.A.C.A.; The Lawrence Sperry Award to Frank N. Piasecki, Chairman of the Board, Piasecki Helicopter Corporation; and the Wright Brothers Lecturer, Dr. William Bollay, Technical Director, Aerophysics Laboratory, North American Aviation, Inc., who spoke on "Aerodynamic Stability and Automatic Control."

Honorary Fellowships in the Institute to: American—Capt. Walter S. Diehl, U.S.N., Assistant for Research Liaison, Office of Assistant Chief, Bureau of Aeronautics, Department of the Navy; Foreign—Sir Henry Tizard, Chairman, Advisory Council on Scientific Policy, Ministry of Defence, England.

Fellowships in the Institute to: Milton B. Ames, Jr., Chief, Aerodynamics Research Branch, N.A.C.A.; Rear Adm. Calvin M. Bolster, U.S.N., Assistant Chief for Research and Development, Bureau of Aeronautics, Department of the Navy; Edward F. Burton, Chief Engineer, Santa Monica Plant, Douglas Aircraft Company, Inc.; Lt. Gen. Benjamin W. Chidlaw, U.S.A.F., Commanding General, Hdqs., A.M.C., Wright-Patterson Air Force Base; Sherman M. Fairchild, Sherman Fairchild and Associates; Robert L. Hall, Chief Engineer, Grumman Aircraft Engineering Corporation; George S. Schairer, Staff Engineer, Aerodynamics and Power Plant, Boeing Airplane Company.

The Secretary announced that the Council had elected the following officers of the Institute for 1951: President, Lawrence B. Richardson; Vice-Presidents, Raymond D. Kelly, W. C. Rockefeller, William T. Schwendler, and Edward C. Wells; Director, S. Paul Johnston; Treasurer, E. E. Aldrin; Secretary, Robert R. Dexter; and Controller, Joseph J. Maitan.

ROBERT R. DEXTER, *Secretary*

President's Report

DURING 1950 THE INSTITUTE has continued its growth and expanded its many services to its members and to the Nation. Through its regular and special publications, its excellent aeronautical libraries, and its technical meetings and lectures, the Institute has again demonstrated its ability to further the advancement of aeronautical engineering by the highest standard of professional interchange, encouragement, and service.

In this brief report I cannot attempt to summarize the numerous activities of the year. I refer you to the Director's Report and the Treasurer's Report for the facts and figures reflecting the Institute's 1950 achievements. Instead it seems appropriate at this time to look ahead at some of the problems confronting the aeronautical engineering profession and the organization that serves the profession.

Probably, every member of the Institute has already felt, in his personal field of activity, the growing pressure upon his time and his skills as the world crisis deepens. With the Nation already committed to vast increases in defense preparations, it is inevitable that the demands upon the aeronautical sciences will continue to multiply. Ours is the tool that must forge the essential weapon of superior air strength.

As qualified practitioners of the aeronautical sciences, members of the Institute individually have the responsibility of doing everything in their power to expand the capacity for aeronautical progress. Boiled down, this simply means that we must spread the job and spread the know-how. In academic fields it involves business as usual, with, perhaps, more crowded classrooms and laboratories and a little extra patience, ingenuity, and hard work contributed by the instructor. In the area of practical application—our aircraft design rooms, the technical branches of the armed forces, and all technical organizations contributing to the total effort—it means going out of our way to guide and train the newcomer, cooperating smoothly with one another, and contributing in every possible way to the maximum utilization of every hour of available technical capacity. We must make every hour and every minute count.

From the standpoint of the Institute, the future holds heavy responsibility and many problems. It is essential that the constructive interchange of technical ideas, primary mission of the Institute, be maintained and, wherever possible, streamlined. In this activity the Institute will be handicapped by the increasing demands on the time of its members. Eventually, it may also face the problem of maintaining adequate interchange despite increasingly rigid security requirements. In this problem, as in all others associated with the Nation's defense, I am confident that proper solutions can be reached in cooperation with the responsible Government agencies.

The capable staff of the Institute has already volunteered its full cooperation to the armed forces and to other research and technical branches of the Government, and the Institute is actively planning to serve in every possible way. Both through the individual efforts of

its members and through the unique facilities and activities of the organization, the Institute will unquestionably be privileged to play a major part in the job ahead.

It has been a pleasure and a deeply appreciated honor to serve as president of the Institute during the past year. I wish to express my appreciation to the Council and to the Director and his staff for their cooperation and support. I also want to extend my congratulations and very best wishes to Admiral Richardson, our distinguished president for 1951.

J. H. KINDELBERGER, *President*

Treasurer's Report

YOUR TREASURERS HAVE BEEN perenially faced with problems such as the maintenance of essential services in the face of continually rising costs with income remaining fairly constant, supervision of a wider scope of activities requiring financial judgment, the forecasting of yearly operations, etc. Where the service departments of the I.A.S. want to provide more meetings, print larger size publications, and increase the scope of all activities, these expanding plans must necessarily be weighed against how much income we can expect to receive during the year. Our budgeting has again been reasonably accurate and our Annual Report, condensed in this issue, shows that we completed the fiscal year in the black.

The REVIEW shows increased revenue over the preceding year and the JOURNAL, as usual, a slight gain. The 1950 CATALOG net expense resulted from a revised format, with reduced rates over the prior year to encourage companies to submit their engineering data for publication. From data on hand it is expected that the 1951 CATALOG will break even.

The operations of the Los Angeles Building were satisfactory, and the year closed showing a net operating income of $998.47.

In San Diego, the recently completed building was "drafted into military service." The expanding aircraft industry in that area required facilities that our building was able to provide. It is planned that the income resulting from the existing arrangement will be funded for subsequent activities in that region.

As usual, the Pacific Aeronautical Library performed its valuable and economical services with a minimum of expense to participating companies and agencies. As a result of purchasing back issues of necessary reference books and magazines, this year the Library invaded its surplus account. One of the purposes for which the account exists is to acquire costly reference works when possible.

During the year, the I.A.S. agreed to assist in the management of the American Helicopter Society's program, including the maintenance of its financial records. This additional accounting has been integrated with our system.

Several important policies have been adopted during the past 12 months which I feel should be brought to your specific attention.

Your Finance Committee, which is represented by members with a broad financial background and assisted in a consultant capacity by the Investment Service Division of the Chase National Bank, reviewed the investment policy of the I.A.S. After detailed consideration, they suggested to the Council a revised investment program in an effort to safeguard, to the best of their ability, the value of all funds under the Institute's jurisdiction. Where applicable, a formula of diversification on the basis of a percentage in equities and preferred holdings, with the balance remaining in various types of Government bonds, was adopted and put into effect.

The second general policy adopted was to segregate from what is considered normal operating income any extraordinary and usually nonrecurring income in a substantial amount. By handling such income (or expenses) directly through Surplus, we can maintain and check our figures with prior years' operations on a comparable basis.

The market value of all Funds as of December 31, 1950, was $60,679.89 in excess of its present book value and $279,435.06 in excess when compared to the value of these Funds as originally donated or when purchased.

A balanced budget for the current fiscal year has been approved by the Council.

Our books were examined by Harris, Kerr, Forster & Company, Certified Public Accountants. A briefed-down copy of their certified statement is published in this issue (page 15).

ELMER A. SPERRY, JR., *Treasurer*

Director's Report

THE INSTITUTE'S PROGRESS REPORT for 1950 does not make particularly exciting reading. No outstanding events, such as the 1949 International Aeronautical Conference or the opening of our Western Buildings, marked the year just closed. We can only report continuous and steady growth in all departments—in size, in service, and in financial stability. As we move into another period of international uncertainty, your Institute stands firmly on a solid foundation, prepared to cope with whatever strains may be imposed during the current period of national emergency.

Meetings

The attendance at all the national meetings during 1950 was greater than that of the preceding year. (The fiscal stringencies imposed by the so-called economy programs of 1948–1949 had limited both time and travel funds.) The quality of papers presented and of the open discussion in meetings was high. Toward the end of the year, however, the effect of tightening security restrictions began to be felt.

The 1950 National Meetings of the Institute included: Eighteenth Annual Meeting, New York City; Fifth Annual Flight Propulsion Meeting, Cleveland; Sixth Annual Personal Plane Meeting Wichita, Kan.; Annual Summer Meeting, Los Angeles; Thirteenth Wright Brothers Lecture, Washington, D.C.; Wright Brothers Lecture, Cleveland.

In connection with the Eighteenth Annual Meeting in New York in January, 1950, a visit was made to the Wright Aeronautical Corporation's high-altitude turbine laboratory at Wood-Ridge, N. J.

As a part of the Annual Summer Meeting, a group of 250 members visited the Edwards Air Force Base at Muroc, Calif.

During November, a group of 150 members made a 2-day inspection of the Navy's research and development activities at the Naval Air Material Center, Philadelphia, and the Naval Air Development Center, Johnsville, Pa.

In the course of the year, the 23 I.A.S. Sections held 144 meetings. Many technical papers were read at these meetings.

Student Branches (70) conducted approximately 317 meetings under I.A.S. auspices.

Membership

The membership situation continues to be satisfactory. Early in the year it was decided to remove from the rolls a block of some 250 foreign members that

INSTITUTE OF THE AERONAUTICAL SCIENCES, INC.

Statement for the fiscal year October 1, 1949, to September 30, 1950

Consolidated Balance Sheet and Operating Statement

ASSETS

General Fund Assets:		
Cash on Deposit	$ 70,168.99	
Accounts Receivable—Net	12,965.95	
Advances on Intrafund Accounts	28,112.84	
Deposits and Prepayments	13,124.15	
Furniture and Fixtures	5,000.00	
Investments	219,950.75	
Los Angeles Building Operating Fund	16,678.19	
San Diego Building Operating Fund	8,820.46	
Pacific Aeronautical Library Fund	10,095.44	
Daniel Guggenheim Park (Assessed Value—$454,450.00)	1.00	
Books, Prints, Models, Medals, etc.	1.00	
Aeronautical Index	1.00	
Total General Fund Assets		$384,919.77
Restricted Fund Assets:		
The Thurman H. Bane Award Fund	$ 800.00	
The Sherman M. Fairchild Fund	16,175.75	
The Paul Kollsman Fund	69,000.00	
The Vernon Lynch Award Fund	37,394.87	
The Minta Martin Aeronautical Fund	538,834.89	
The Sylvanus Albert Reed Award Fund	13,462.35	
The Lawrence Sperry Award Fund	13,227.00	
New York Building, Maintenance and Reserve Fund	324,940.50	
Los Angeles Building and Reserve Fund	398,811.45	
San Diego Building and Reserve Fund	181,147.87	
Total Restricted Fund Assets		$1,593,794.68

LIABILITIES, RESERVES, AND UNEXPENDED INCOME

General Fund:		
Accounts Payable and Deposits	$ 16,144.10	
Deferred Credits to Income (Dues & Subscriptions)	69,394.30	
Deferred Credit to Employees' Retirement Fund	1,827.19	
Reserve for Building Repairs	4,840.00	
Pacific Aeronautical Library Fund	10,095.44	
Los Angeles and San Diego Building Funds (intrafund transactions)	25,498.65	
Unexpended Income:		
Balance September 30, 1950	257,120.09	
Total Liabilities, Reserves, and Unexpended Income		$384,919.77
Restricted Funds:		
Principal of Gifts and Unexpended Income (See Assets)		
Total Restricted Fund Liabilities		$1,593,794.68

Statement of Income and Expenses

General

INCOME

Dues (less subscriptions)	$157,367.75	
Entrance Fees	2,600.00	
Investment Income	8,686.89	
Miscellaneous	3,150.92	
Excess of Income over Expenses:		
Journal of the Aeronautical Sciences	3,006.35	
Aeronautical Engineering Review	3,712.46	
Total Income		$178,524.37

EXPENSES

Administrative and Clerical Salaries	$ 95,680.25	
General Office Expenses—Net	58,885.17	
Excess of Expenses over Income:		
Library Costs	19,295.46	
Aeronautical Engineering Catalog	1,884.00	
Total Expenses		$175,744.88
Net Operating Income for the Year Ending September 30, 1950		$ 2,779.49

Journal

INCOME

Subscriptions	$ 34,398.88	
Reprints	473.11	
Total Income		$34,876.99

EXPENSES

Editorial and Clerical Salaries	$ 6,234.25	
Publication and Other Expenses	25,636.39	
Total Expenses		$31,870.64
Excess of Income over Expenses (See General Income)		$3,006.35

Review

INCOME

Advertising Revenue	$ 87,077.95	
Subscriptions	17,758.19	
Total Income		$104,836.14

EXPENSES

Editorial, Advertising, and Clerical Salaries	$ 36,725.13	
Publication and Other Expenses	64,398.55	
Total Expenses		$101,123.68
Excess of Income over Expenses (See General Income)		$3,712.46

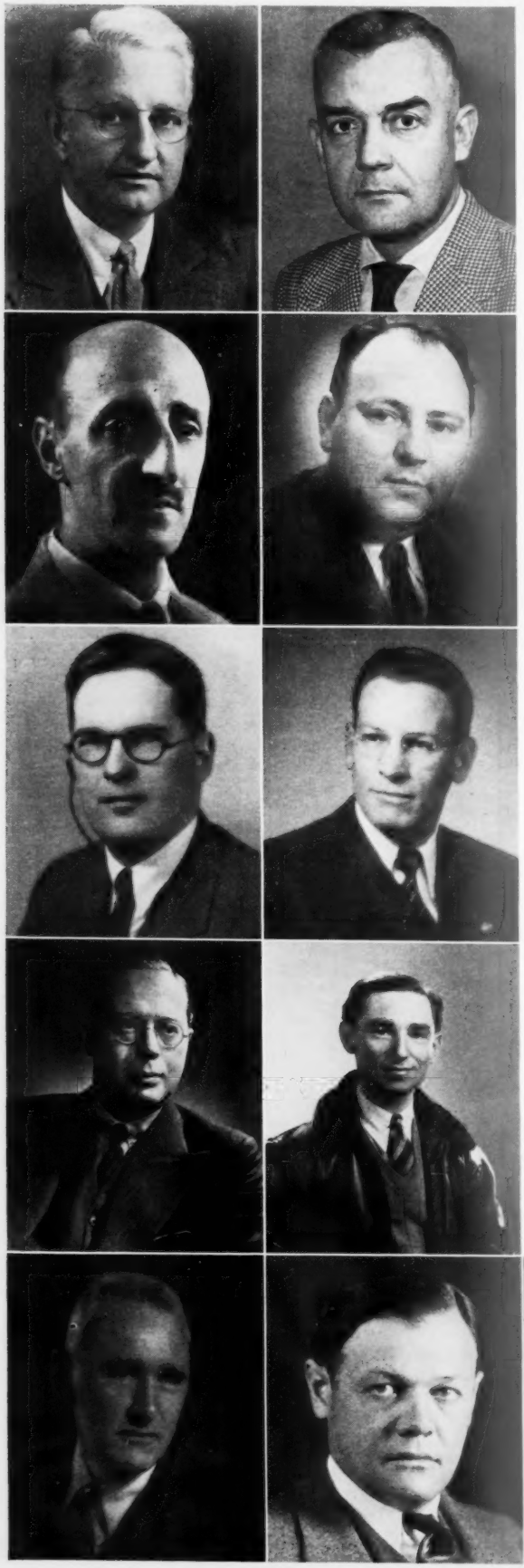
Catalog

INCOME

Advertising Revenue	$ 18,385.00	
Sales and Reprints	303.06	
Total Income		$18,688.06

EXPENSES

Editorial and Advertising Salaries	$ 6,022.00	
Publication and Other Expenses	14,550.06	
Total Expenses		$20,572.06
Excess of Expenses over Income (See General Expenses)		$1,884.00



Newly Elected Members to the Institute Council

Eastern Area

John W. Crowley, Jr., Associate Director for Aeronautical Research, N.A.C.A.

Walter Tydon, Chief of Design Engineering, Fairchild Aircraft Division, Fairchild Engine and Airplane Corporation

Central Area

A. Francis Arcier, Consultant, Hdqs., Air Materiel Command

Vernon Outman, Chief Technical Engineer, McDonnell Aircraft Corporation

Western Area

Alfred S. Niles, Professor of Aeronautical Engineering, Aeronautics Laboratory, Stanford University

L. Eugene Root, Chief, Aircraft Division, The RAND Corporation

Council Members

William A. M. Burden, Special Assistant to the Secretary of the Air Force

Roger W. Kahn, Service Manager and Test Pilot, Grumman Aircraft Engineering Corporation

Earl D. Osborn, Chairman of the Board, Edo Corporation

Elmer A. Sperry, Jr., Treasurer, Sperry Products, Inc.

E. S. Thompson, Manager of Sales, Aircraft Gas Turbine Divisions, General Electric Company

had been carried for some years before World War II and who, for the past 5 years or more, had not paid dues. Also, as is usual, the ROSTER was cleared of all those members whose dues were not received by 15 March. In spite of these reductions and the normal annual attrition, we ended our year with an overall gain of over 400 members.

A noticeable pickup in transfer from Student to Technical Member is evident. This resulted from an active follow-up program by our Membership Department among the graduating students. With the prospective reduction in numbers of aeronautical engineering graduates in the immediate future, the pickup from this source in the years immediately ahead will probably not be so great.

The trend toward increasing Section activities continues. During the year, four new Sections were activated—St. Louis, Hampton Roads, Pittsburgh, and Montreal. The number of members in organized Sections went up to almost 6,500. Student Branch activities also continued at a high level.

Publications

Journal of the Aeronautical Sciences

With a backlog on hand, the Editorial Committee has been screening material more carefully to meet the needs of JOURNAL readers. New specifications have been prepared, designed to make for greater condensation of material presented.

One of the most significant indications of JOURNAL readership is the rise in volume of the "Readers' Forum." This department was started a year ago with a fraction of a page. It now averages 6-8 pages per issue and is becoming as valuable as the discussion periods at our annual meetings.

The JOURNAL now has a paid circulation of 6,000.

Aeronautical Engineering Review

The REVIEW is now firmly established as the outstanding technical publication for the aeronautical (and allied) engineering profession. As fast as its income has warranted, it has been continuously expanded in content. Reports from the field indicate that, in its present form, it is serving the needs of the membership for engineering articles, for a current index of aeronautical literature, and for news of the Institute. Its article content has been expanded during the past year, and, if the trend toward increased advertising volume continues, the number of engineering and technical articles per issue will be increased.

The REVIEW has a paid circulation of about 10,000. As indicated in the Treasurer's report, it is on a self-supporting basis.

Aeronautical Engineering Catalog

During 1949, editorial changes in the CATALOG were designed to make the book of greater value to the engineering user. Because of this shift in policy, sales volume was reduced to the point that the edition was published at a small loss (under $2,000). During the current year, however, the sales volume was built up sufficiently to more than offset rising production costs, and it is anticipated that the current CATALOG will again be in the black.

Roster of Members

The regular ROSTER OF MEMBERS was again published in 1950. As for the past 3 years, a part of its publication cost was met by the sale of advertising pages.

The advertising pages were offered to Corporate Members of the Institute and to regular REVIEW advertisers at a low "premium" rate.

MEMBERSHIP BREAKDOWN

	12/31/48	12/31/49	12/31/50
Temporary Honorary Members	21	17	18
Honorary Fellows	20	21	22
Fellows	185	184	184
Associate Fellows	600	624	635
MEMBERS	2,981	3,108	3,114
Associate Members	416	405	367
Historical Associate Members	New Grade—1/49	56	68
Technical Members	2,908	3,449	3,899
Totals	7,131	7,864	8,307
Student Members	4,068	3,958	3,395

I.A.S. SECTIONS AND STUDENT BRANCHES

	12/31/47	12/31/48	12/31/49	12/31/50
Number of Sections	17	19	19	23
Number of Section Meetings	92	121	126	144
Number of Members in Section	4,734	5,032	5,718	6,436
Number of Branches	51	60	67	70
Number of Branch Meetings	277	327	336	317

Aeronautica

The Institute's quarterly bulletin for Historical Associates was continued. It is available to regular I.A.S. members at $1.00 a year. It now has about 750 subscribers. No advertising is carried.

Fairchild Fund Publications

I.A.S. preprints and special reports continue to be produced in quantity with the support of this Fund. During 1950, 46 new titles were added and a total of 12,700 copies of all titles were distributed.

Library Services

The increasing tempo in industry is being reflected in noticeably greater demands upon our Library services, particularly in the West, where our Pacific Aeronautical Library maintains a daily indexing and abstracting service. This has become an essential tool for the aeronautical industry in the Los Angeles area. Plans are under way greatly to improve the services there by the installation of a Central Air Documents Office Index. This will require additional equipment and personnel, but a proposal is being prepared for presentation to CADO for a contract to underwrite the costs involved.

Work has progressed during the year on the preparation of a cataloging of I.A.S. Libraries. Personnel shortages have prevented its completion in 1950, as planned, but it is anticipated that the index will be published early in 1951.

Archives

The Historical Associates group has been growing slowly. An active chapter has been formed in the Los Angeles area. The number of voluntary contributions of articles for AERONAUTICA has been gratifying.

Largest addition to the I.A.S. Archives came in the form of a gift of the library and a large collection of apparatus from the estate of the late Dr. Robert H. Goddard. This material came to the Institute through the generosity of his widow, Mrs. Esther C. Goddard. It has been installed in the center room on the second floor of the I.A.S. New York Building as a permanent exhibit.

Relations with Other Societies

Cooperative meetings with a number of other engineering societies were held during the year on both National and Section levels. In addition, the following special arrangements may be noted:

The Royal Aeronautical Society

During 1950, constant contact was maintained with officers of the R.Ae.S. in London in planning for the Third

International Aeronautical Conference scheduled for September, 1951. Dates have been set (September 7–11, 1951), a meeting place has been selected (Brighton, England), and the technical programs have been outlined. The Secretary of the R.Ae.S. came to the United States in January (1951) to finalize the plans for the Conference.

The American Helicopter Society

In accordance with an agreement jointly worked out with officers of the A.H.S., its headquarters was established at 2 East 64th Street, New York City, in the Spring of 1950. A part-time secretarial assistant is handling the Society's affairs. The records and bookkeeping have been integrated with those of the Institute.

American Rocket Society

Joint discussions have been under way during the Fall of 1950 looking toward closer coordination of activities between the I.A.S. and the A.R.S.

Guggenheim Aviation Safety Center

During the Fall of 1950, the space previously occupied by the Standard Aeronautical Indexing project was made available for an extensive research project conducted by The Daniel and Florence Guggenheim Aviation Safety Center at Cornell University. This activity is under the direction of Jerome Lederer, who is also Director of the Flight Safety Foundation.

Use of Buildings

Few changes were made during 1950 in the New York Building. Within the next year, a certain amount of interior painting will be required, since some of the 1945 redecorating has deteriorated to the point of replacement. Funds for such maintenance, however, are on hand and will not affect the budget for the current year.

Extensive modification of the heating system will be necessary before the building is thoroughly satisfactory. A survey of the requirements has been made, but no expenditures will be made before the summer of 1951, and then only after the surveys have been fully analyzed.

Use of the Los Angeles Building has been continuously on the increase. The requirements of our tenants (the A.I.A. and the N.A.C.A.) have been satisfactorily met. The auditorium is in use, on the average, three to five times a week, and the small meeting rooms are in use almost daily for various committee and board meetings. Several repairs and maintenance jobs have been necessary to keep the building in first-rate condition.

The L.A. Building operation ended the 1949–1950 fiscal year in the black, but, because of a substantial increase in our taxes, we are facing a deficit for the current year. Discussions are under way with the Manager, Western Region, and the Building Management Committee to try to restore a balanced budget.

As reported in the REVIEW (October, 1950), the San Diego Building has been leased to Consolidated Vultee Aircraft Corporation "for the duration." Under the lease agreement, Convair will return the building to us in good condition, and any net funds accrued under the lease will be earmarked for the future support of San Diego activities.

Educational Aid Funds

With funds that may become available as a result of the sale of the Sands Point property and the release of other restricted funds, plans are being discussed in the Council for the establishment of a group of I.A.S. Scholarships and Fellowships. A Committee of outstanding engineers and educators has been appointed to study the problem, and it is anticipated that announcement can be made of the program by the time of the Annual Summer Meeting.

Emergency Program

The Council and Management of the Institute have been considering policy and programs for this organization as the national emergency becomes more acute. Staff studies have been made for the conduct of all departments and for the protection of I.A.S. properties. The major objectives are to make all I.A.S. activities contribute a maximum to the defense effort and, at the same time, to preserve our assets under anything short of completely catastrophic conditions.

I.A.S. Staff

A major change in our staff setup occurred in September with the resignation of our Assistant Director, James L. Straight, to take over an industry job. Mr. Straight had capably handled I.A.S. affairs on the West Coast for over 3 years. The successful completion of the building plans both at Los Angeles and at San Diego stemmed largely from his energy and coordinating ability. We were sorry to lose him. We were fortunate, however, in securing the services of Ernest W. Robischon, a long-time friend of the Institute and an associate (as a civilian member of the Wright Field Staff) in the Standard Aeronautical Indexing project. Mr. Robischon reported in at Los Angeles as our Western Region Manager in mid-September. Since then he has been indoctrinating himself in our problems on the coast from Seattle to San Diego.

No other major staff changes have been made during the past year. I should like to close this annual account of our activities with a sincere tribute to the loyalty and the efficiency of our staff people. Day in and day out, each is carrying his own responsibilities and is cooperating fully with every other staff member to carry out the directives of the Council and to maintain all Institute services at a maximum.

S. PAUL JOHNSTON, *Director*

I.A.S. Roster of Members

The *1951–1952 Roster of Members*, in order to render a greater service, will include a listing of members by their company affiliation, in addition to the regular alphabetical member listing. For this reason, it becomes doubly important that the data card you have received be filled out completely and returned promptly. The information you supply will form the basis for your listing. Please use extra care in following the instructions on your data card.

Every effort will be made to make this our most complete Roster. Only with the cooperation of all members can this goal be achieved.

A Brief Report on the

FOURTEENTH WRIGHT BROTHERS LECTURE

A PRECEDENT WAS SET THIS YEAR when the Institute of the Aeronautical Sciences Fourteenth Wright Brothers Lecture was given in five different localities from Washington, the capitol, to Washington, the state. About 400 of the nation's leading aeronautical engineers and scientists heard its initial presentation in Washington, D.C., on December 16 by Dr. William Bollay, Technical Director, Aerophysics Laboratory, North American Aviation, Inc. In addition, audiences in Cleveland, Los Angeles, San Francisco, and Seattle were also privileged to hear Dr. Bollay personally deliver his address on "Aerodynamic Stability and Automatic Control." These last four presentations were given on December 19 in Cleveland, January 4 in Los Angeles, February 15 in San Francisco, and February 16 in Seattle.

In his address on "Aerodynamic Stability and Automatic Control," Dr. Bollay gave his audiences a perspective of the general technology developed for the dynamic evaluation of aircraft and missiles.

"Faster-thinking electromechanical controls, to replace pilots, are required to handle supersonic aircraft and guided missiles," Dr. Bollay asserted.

"The age of supersonic flight," he said, "has brought whole families of new problems of control. Consider, for example, the problem of shooting down a 600-m.p.h. bomber with an interceptor capable of a speed of 1,000 m.p.h. The time available for interception is likely to be so short that the interceptor must be vectored by ground control into the approximate attack position. If the attack proceeds from the front, the relative speed between the two aircraft is 1,600 m.p.h. If the interceptor pilot first sees the bomber 5 miles away, he has 11 seconds to identify his target, line up his airplane, fire his guns, and get out of the way. The likelihood of scoring a hit under conditions of such a high closing rate is very low. If he decides to go around to make an approach from the rear, even if he turns at 4G normal acceleration, it will require a 6-mile diameter circle to turn around and a time of 60 seconds. During this time, the bomber has traveled 10 miles and has therefore a good possibility of being under cloud cover. It is because of such considerations that the automatic fighter and, eventually, the guided missile will be required to intercept high-performance bombers."

In another part of his lecture, Dr. Bollay stated: "After a high degree of reliability has been achieved [in military aircraft], the automatically controlled airplane will also have important peacetime potentialities. The transport aircraft of the future may well be on automatic control from the moment of takeoff to the automatic landing at the other end. Such a system would free the air transport of its most serious handicap—the weather. The human pilot would serve mainly to oversee the flight instruments and take over in case of emergency."

Dr. William Bollay, Fourteenth Wright Brothers Lecturer.

Dr. Bollay discussed potentialities other than those of the automatic flight and landing systems related to aircraft. These included the automatic cruise control of propulsion systems, the possibility of reducing the effects of gusts on aircraft, and the control of longitudinal dynamic instability of seaplanes.

The lecture in its entirety will be printed in a forthcoming issue of the JOURNAL OF THE AERONAUTICAL SCIENCES.

The Wright Brothers Lecture, established in 1937 by The Vernon Lynch Fund, is presented annually by the I.A.S. and commemorates the first airplane flight made by the Wright Brothers in 1903.

(Left) **Dr. Hugh L. Dryden, Director, N.A.C.A., Chairman of the Lecture.** ***(Right)*** **Lecture discussers at Washington, D.C., include, from left to right: Preston R. Bassett, President, Sperry Gyroscope Company, Division of The Sperry Corporation; Harry J. Goett, Ames Aeronautical Laboratory, N.A.C.A.; W. F. Milliken, Jr., Manager, Flight Research, Cornell Aeronautical Laboratory, Inc.; Robert C. Seamans, Jr., Professor, Department of Aeronautical Engineering, Massachusetts Institute of Technology.**

General News

Marquardt Aircraft Company Joins I.A.S.

The most recent addition to the corporate-membership ranks of the Institute of the Aeronautical Sciences is Marquardt Aircraft Company. Marquardt was founded in 1944 by Roy E. Marquardt, an Associate Fellow of the Institute, and a group of associates in answer to the Government's need for a private industry to carry on research and development in the ram-jet engine field.

The initial work was done in conjunction with the Naval Research Laboratory, University of Southern California, and involved the development of the first 20-in. diameter, 2,500-hp., subsonic ram-jet engine. Subsequent contracts included development of 30-in. diameter, 10,000-hp., and 48-in. diameter, 15,000-hp. subsonic engines. The first known flights of man using only ram-jets for power were accomplished with Marquardt 30-in. ram-jets mounted on the wing tips of an F-80. The success of the 20-in. diameter subsonic engine led to its use on the Martin "Gorgon" Target Drone. As far as is known, the first production order for ram-jet engines resulted from this program.

Under U.S.A.F. sponsorship, Marquardt has constructed a jet-engine testing laboratory capable of testing the largest air-breathing jet engines now under development in this country. It is also used for testing fuel-control and accessory-drive equipment. Additions to the facility are now being made to increase its testing capacity further. The complete facility will represent an investment of over $2,000,000 and will permit testing of full-scale flight-type ram-jet engines at simulated flight speeds approaching 2,000 m.p.h. and simulated altitudes from sea level to over 50,000 ft.

The company also engages in research, development, and manufacture of pulse-jet and turbojet engines and their related controls. Pulse-jet engines for target-drone application are currently in production.

Primary activity of the company at the present time is the development of supersonic ram-jet engines and related accessory and control equipment. Considerable work is also being performed on air-turbine-type accessory-drive units for special applications.

The main plant of Marquardt, located at 7801 Hayvenhurst Ave., Van Nuys, Calif., immediately adjacent to the San Fernando Valley Airport, has over 100,000 sq.ft. of floor area. Additional shops are maintained at Pt. Mugu and at Oxnard, Calif., where electronic-engineering and air-frame modification work are being performed for the U.S. Navy. Personnel of the company now totals approximately 350.

The officers and key personnel of Marquardt include: President, Mr. Marquardt, A.F.I.A.S.; Vice-President, George P. Tidmarsh; Secretary-Treasurer, W. H. Schwebel; Manager of Engineering and Manufacturing, Don L. Walter, T.M.I.A.S.; and Chief Engineer, John A. Drake, M.I.A.S.

A.T.A. Elects Directors; Admiral Land Plans to Resign

Among those elected to membership on the Board of Directors for the 1951 calendar year at the stockholders' meeting of the Air Transport Association were: Robert M. Love, M.I.A.S., President, All American Airways, Inc.; C. R. Smith, A.M.I.A.S., President, American Airlines System; Juan T. Trippe, A.M.I.A.S., President, Pan American World Airways, Inc.; and W. A. Patterson, M.I.A.S., President, United Air Lines, Inc.

The new Board of Directors meeting, held immediately thereafter, re-elected all A.T.A. officers. At the same time Vice Adm. Emory S. Land, U.S.N. (Ret.), F.I.A.S., gave notice of his intention to resign his position as President of the A.T.A. effective December 31, 1951.

Prototype Aircraft Advisory Committee Established

A Prototype Aircraft Advisory Committee has been established by the C.A.A. as one of the first steps in administering the Prototype Aircraft Act, which became law on September 30. The Act states it to be the policy of Congress to promote "the development of improved transport aircraft, particularly turbine-powered aircraft, aircraft especially adapted to the economical transportation of cargo, and aircraft suitable for feeder-line operation."

Donald W. Nyrop, Administrator, C.A.A., will serve as Committee Chairman, while Frederick B. Lee, M.I.A.S., Deputy Administrator for Program Planning, C.A.A., will act as alternate. Harold D. Hoekstra, A.F.I.A.S., C.A.A.'s Office of Aviation Safety, will be Executive Secretary.

The first meeting of this newly formed Committee was planned for January. Committee members are composed of representatives from the Department of Defense, C.A.B., N.A.C.A., Air Line Pilots Association, Aircraft Industries Association, Air Transport Association, and Air Coach Transport Association. The four domestic certificated cargo carriers and two overocean irregular carriers were asked to select one representative for each of the two categories.

R. W. Darrow Selected for Award

The Baltimore Junior Association of Commerce "Most Outstanding Young Man of the Year" award committee has selected Richard W. Darrow, A.M.I.A.S., Director of Public Relations, The Glenn L. Martin Company, for the 1950 honor. This award is presented annually to that young man between the ages of 21 and 36, who, in the opinion of the Board of Judges, has contributed most to the civic and commercial life of Baltimore during the calender year.

Mr. Darrow, 35, was especially cited for his leadership of the Friendship International Airport Dedication Committee. In addition, he has spearheaded drives for the Red Cross, Community Chest, and other welfare programs and has assisted school and church organizations by providing program material and speakers. He has also served on numerous committees.

A native of Ohio, Mr. Darrow was graduated from Mechanicsburg High School. In 1936, he received his degree from Ohio Wesleyan University and now serves as a member of its Alumni Board of Directors. He came to Baltimore in May, 1946.

Richard W. Darrow

W. A. M. Burden Adds to Library Gift

A valuable collection of aeronautical pamphlets was added in 1950 to his previous gifts by W. A. M. Burden. These included several hundred items on balloons and airships in the 19th and 20th centuries in the U.S., France, Germany, England, and Russia. A large number of pamphlets on military aviation, air races, biography, instruments, and air law in the same period was included in the gift. The section on legislation, containing texts of resolutions, bills, reports, and laws, is especially comprehensive for the years 1933 through 1939. Catalogs of foreign and domestic manufacturers and a large file of magazine articles arranged by subjects complete this unusual collection, which is valued at more than $1,250.

News of Members

▸ **Dr. R. Paul Harrington** (A.F.), member of the Advisory and Editorial committees of the I.A.S., Professor and Head of the Department of Aeronautical Engineering, Rensselaer Polytechnic Institute, has been appointed Chief Editor of the *Aeronautical Engineering Handbook*, the first comprehensive authority in that field. The first edition is expected to appear early in 1953. Dr. Harrington succeeds the late Dr. Alexander Klemin, a Founder Member, Benefactor, and Fellow of the I.A.S., who undertook the assignment 3 years ago.

▸ **Eric Reissner** (A.F.), Professor, Department of Mathematics, Massachusetts Institute of Technology, was recently elected a Fellow of the American Academy of Arts and Sciences.

▸ **Delos W. Rentzel** (H.M.), Chairman, C.A.B., was presented with a citation at the December 8 Aviation Associates First Annual Show and Dance in Philadelphia. The citation was for Mr. Rentzel's outstanding work in the promotion of aviation while C.A.A. Administrator.

▸ **Dr. Theodore Theodorsen** (F.) has left his position as Dean of the School of Engineering, Institute of Technical Aeronautics of Brazil, São Paulo, Brazil, and has returned to the United States.

▸ **Thomas J. Watson, Jr.** (A.M.), Executive Vice-President, International Business Machines Corporation, was elected a Vice-Chairman of the U.S. Council, International Chamber of Commerce.

Members on the Move

This section has been instituted to give information on the latest affiliations of I.A.S. members. All members are urged to notify the News Editor of changes as soon as they occur.

Elliot L. Adams, Jr. (T.M.), now with the Armed Forces. Formerly, with Engineering Department, Boeing Airplane Company.

Edwin J. Burnell (M.), Chief Mechanical Product Engineer, Guided Missile Production, Hughes Aircraft Company. Formerly, Production Project Engineer, Fairchild Guided Missile Division, Fairchild Engine and Airplane Corporation.

Joseph A. Chamberlin (T.M.), Mechanical Controls Group, Engineering Department, Douglas Aircraft Company, Inc. Formerly, Vice-President and Production Manager, Chamberlin Metal Products.

John T. Deden (T.M.), Components Design Engineer, Aeronautical Division, Minneapolis-Honeywell Regulator Company. Formerly, Design Layout Engineer, McDonnell Aircraft Corporation.

HEADS NEW DEPARTMENT

George S. Trimble, Jr. (M.), has been made Head of the newly established Design Development Department of the Engineering Division, The Glenn L. Martin Company. The four major functions of the new department are: (1) to develop improved designs on existing projects; (2) to develop new designs in response to customer bid invitation; (3) to conduct design research and analysis, with emphasis on long-term trends and new business potential; and (4) to supervise special contracts of a design-study nature. Mr. Trimble, who was formerly Chief Aerodynamics Engineer, has been in Martin engineering for 13 years.

Ralph N. DuBois (A.F.), Dean, School of Aircraft Engineering, Institute of Technical Aeronautics of Brazil, São Paulo. Formerly, Professor in Charge, Department of Engines, Institute of Technical Aeronautics of Brazil.

Wesley J. Fisher (M.), Supervisor of Production, Maintenance Base, Northwest Airlines. Formerly Production Engineer, United Air Lines' Maintenance Base.

John Glaser (M.), Production Engineer, Guided Missile Production, Hughes Aircraft Company. Formerly, Senior Design Engineer, Fairchild Guided Missiles Division, Fairchild Engine and Airplane Corporation.

Harold R. Goodman (T.M.), Aerodynamicist, Lockheed Aircraft Corporation. Formerly, Aeronautical Research Scientist, N.A.C.A., Langley Air Force Base.

L. R. Gutstadt (T.M.), Engineer Assistant, Performance Group of Aerodynamics, Northrop Aircraft, Inc. Formerly, Engineering Draftsman and Mathematician, Northrop Aircraft.

James R. Hanson (T.M.), Junior Engineer "A," Ryan Aeronautical Company. Formerly, Test Engineer, Minneapolis-Honeywell Regulator Company.

Harry Joseph Irwin, Jr. (T.M.), now Junior Engineer, Consolidated Vultee Aircraft Corporation.

Paul L. Klevatt (T.M.), Aerodynamicist, Sverdrup & Parcel, Inc. Formerly, Aeronautical Research Scientist (GS-9), N.A.C.A., Langley Air Force Base.

Elizabeth M. Kriegsmann (T.M.), Northrop Aircraft, Inc. Formerly, Research Engineer, Rotary Wing Aircraft, Air Materiel Command, Wright-Patterson Air Force Base, Ohio.

Robert H. Laber (T.M.), Aeronautical Engineer, Helio-Aircraft Corporation. Formerly, Engineering Draftsman, Technical Training Aids, Inc.

Leopold R. Michel (M.), Chief Technical Engineer, Eclipse-Pioneer Division, Bendix Aviation Corporation. Formerly, Senior Engineer, Guided Missiles Division, Fairchild Engine and Aircraft Corporation.

H. Erich Nietsch (M.), Assistant to the President, Robinson Aviation, Inc. Formerly, Dynamic Design Engineer, The Glenn L. Martin Company.

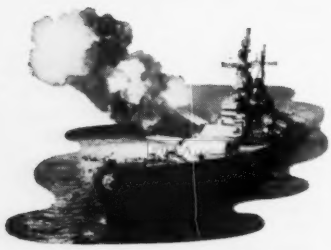
Anthony J. Rinaldi (T.M.), now Stress Analyst "B," Hughes Aircraft Company.

Joseph T. Santy (T.M.), Mathematician "B," Stress Section, North American Aviation, Inc. Formerly, Student.

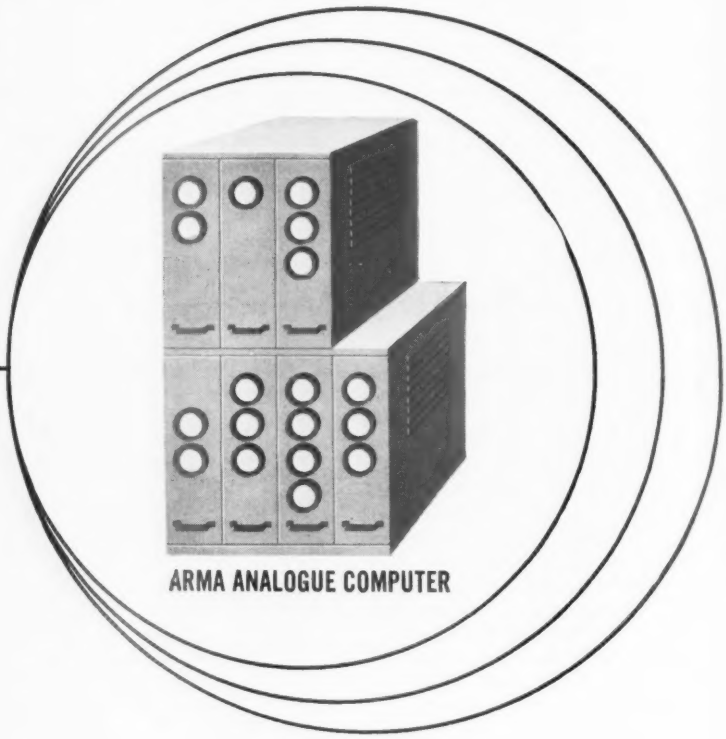
Frank R. Stearns (T.M.), Stress Analyst "B," Stress Department, Piasecki Helicopter Corporation. Formerly, Junior Structures Engineer, Chase Aircraft Company, Inc.

Maurice A. Walter (M.), Senior Electro-Mechanical Engineer, The Glenn L. Martin Company. Formerly, Project Test Engineer, Naval Air Experimental Station, Philadelphia Naval Base.

IN THE AIR



ON THE SEA



YES, AND EVEN UNDER THE SEA

The *Analogue Computer* has long held a high place in Arma's work in such specialized fields as automatic gun-laying and torpedo-data computing for the U.S. Navy. Its present wider application to the needs of the other Services stems largely from accelerated post-war engineering at Arma, which resulted in miniaturizing its components and at the same time making them interchangeable and more accurate.

By this Arma development, the *Analogue Computer* has reached a new level of importance as a contributing factor in the high accuracy of American arms. It is typical of many things developed by Arma engineers to aid in making America safe against those who wish to destroy it.

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Necrology

Lt. Comdr. David Purdon, U.S.N.

Lieutenant Commander David Purdon, U.S.N., was killed in an aircraft accident on October 26, 1950. He was 34 years old.

A Technical Member of the Institute, Commander Purdon was graduated from the U.S. Naval Academy in 1940 with a B.S. degree. He returned to the Academy in March, 1945, to take postgraduate work and in October, 1946, was transferred to the Guggenheim Aeronautical Laboratory, California Institute of Technology, for additional postgraduate work. He received his degree of Aeronautical Engineer from the latter institution in June, 1947. He was also a Naval Aviator.

During his Naval career, Commander Purdon was assigned to engineering duties and to flying Naval aircraft. At the time of his death, he was serving as Maintenance Officer, VC-5, Naval Air Station, Norfolk, Va.

Corporate Member News

• **Aerojet Engineering Corporation** . . . According to an announcement, negotiations were virtually completed last December for the acquisition of a rocket-factory site near Sacramento, Calif. The area comprises approximately 7,200 acres. The new factory represents an initial investment of about $6,000,000. Final negotiations were to have been completed in January, 1951, with construction to follow immediately.

• **Airborne Instruments Laboratory, Inc.** . . . A group of executives and employees of A.I.L., in association with Laurance S. Rockefeller, A.M.I.A.S., and certain of his associates, as well as the American Research and Development Corporation, has purchased the entire capital stock of Airborne Instruments Laboratory from Aeronautical Radio, Inc. This transaction, which took place on December 14, provides that these three groups share nearly equal ownership of the Laboratory.

• **Beech Aircraft Corporation** . . . Mrs. Olive Ann Beech, widow of Walter H. Beech, was elected President and Chief Executive Officer to fill the vacancy created by the recent death of Mr. Beech. Retaining their positions as a result of the December 14 Stockholders' Meeting are: John P. Gaty, Vice-President and General Manager; T. A. Wells, Vice-President and Chief Engineer; Frank E. Hedrick, Vice-President and Coordinator; and L. Winters, Assistant Secretary. John A. Elliott was advanced from Controller and Chief Accountant to Treasurer. Mrs. Beech, Mr. Gaty, Mr. Wells, T. D. Neelands, and Dwight S. Wallace remain on the Board of Directors; Mr. Hedrick is the newly elected member of the Board.

• **Boeing Airplane Company** . . . Boeing and the U.S.A.F. have announced a new model Boeing C-97, designated the KC-97A. The new prototype tanker can be utilized either as a Flying-Boom-type aerial refueling tanker or in its normal capacity as the 300-m.p.h. troop and cargo transport. The KC-97A can make mid-air refueling contacts with the Boeing B-50D Superfortress bomber . . . More than 63 per cent of the air-frame cost of all Air Force planes now under contract for manufacture goes to subcontractors and to parts and material suppliers. Boeing production airplanes included are the B-47 Stratojet bombers, the B-50 Superfortress medium bombers, and the C-97 Stratofreighter transports.

• **Brown Instruments Division, Minneapolis-Honeywell Regulator Company** . . . The industrial production and operating facilities are undergoing an expansion that was made possible by the purchase of the Thomas M. Royal plant in addition to about 60,000 sq.ft. of undeveloped property. The three-story reinforced concrete building, recently acquired, will be completely occupied in February, according to plans.

• **Consolidated Vultee Aircraft Corporation** . . . The U.S.A.F. accepted delivery recently of the first early-model B-36 bomber to be modernized at the San Diego plant. The modernized version has four jet engines and other improvements that make it equal in performance and equipment to the B-36D series. The four General Electric J-47 jet engines and six Pratt & Whitney Wasp Major piston engines generate a total of 42,000 hp. . . . The XC-99 was temporarily withdrawn from service by the Air Force in order to permit the installation of a more rugged landing gear. When fully loaded, the ship weighs 155 tons. The gear to be used is the improved type now used on the B-36.

• **Cornell University** . . . A grant of $5,000 a year for 5 years has been received from The Salvatore Giordano Foundation, Inc., for basic research in the heat-transfer field. The project's purpose will be to study fundamental problems in the transfer of heat in heat exchangers of the finned or extended-surface type with air as the fluid on the side of the secondary surface and with various fluids on the primary or tube side. The general aim will be to determine the optimum extent of secondary surface to obtain the maximum rate of heat transfer per pound of heat-exchanger weight.

• **Fairchild Engine Division, Fairchild Engine and Airplane Corporation** . . . A Long Beach, L.I., building has been leased for use primarily as storage and warehouse space. This will free a corresponding area at the Farmingdale plant for production equipment.

• **General Electric Company, Aircraft Gas Turbine Division** . . . A vast aircraft jet-engine and turboprop test, development, and production center is scheduled to be established at Lockland, Ohio. The stepped-up production will be achieved by (1) more than tripling the space now occupied by G-E in the Lockland plant; (2) establishing facilities for the manufacture of jet-engine components at Lockland; and (3) greatly increasing the present jet-engine assembly operation by increasing the capacity for the manufacture of components from subcontractors. New construction at Lockland was scheduled to start soon after January 1, 1951. As previously announced, the divisions' executive, engineering, and commercial staffs will be moved to Lockland . . . A new atomic radiation detector to permit direct radiation readings at a glance has been announced. Called a "radiation moni-

Attention Members!

All members of the Institute are invited to submit material concerning their activities for publication in the "News of Members" columns of the *Aeronautical Engineering Review*. Responsibility for new developments, awards or honors received, and appointments to new or additional positions are some of the items that your editors believe are of interest to other I.A.S. members. A brief letter or postal card giving exact details will be sufficient. Photographs accompanying news items will be welcomed and will be used where practicable.

Items submitted will be considered on the basis of their timeliness and general interest. Correspondence should be addressed to the News Editor, *Aeronautical Engineering Review*, 2 East 64th Street, New York 21, N.Y.

Here it is. One of the most compact aircraft actuators meeting all military requirements—the ROTORette, adopted for application on the F-84E, F-84F and F-94C. It is ideally suited for valve or damper operation. Compactness and light weight (little more than one pound) make its use mandatory where space or balance is critical.

Limit switches are load sensitive and adjustable for any value up to 50 pound-inches. Motion between travel limits is controlled by *externally adjustable* positive stops, causing a reaction on the load limit switches.

Operating on 26 volts D.C., the ROTORette is available in two models, one of which can incorporate either a position-indicating potentiometer or an intermediate position switch. Both models are qualified for compliance to Specifications AN-M-40 (Motor and Brake, including Filter), USAF-41065 (Environmental for complete actuator), and USAF-41251 (General Electro-Mechanical Actuator Specification).

Write for Bulletin 118.

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tor," the new instrument weighs less than a pound and is about the size of a quart oil can . . . The internal parts of delicate radio and indicating instruments have been made more accessible by a special rig that uses a G-E Calrod heating unit. To help unsolder them simply and quickly, a Calrod heater was bent to follow the shape of an instrument container, and a convenient frame for the heater to hold the Calrod unit in place around the container was constructed.

• **Hamilton Standard Division, United Aircraft Corporation** . . . A new and larger version of its air-conditioning unit for jet-fighter cockpits has been developed. The first of a substantial order was shipped to Lockheed Aircraft Corporation for installation in the F-94C fighter. This unit bleeds hot air from the jet engine and delivers either hot or cold air to the cockpit at a rate of 310 cu.ft. per min. The temperature of the air is automatically controlled by a thermostat in the cockpit, set by the pilot. The air supply can range in temperature from 25° to 400°, depending upon the cockpit requirements and is changed completely four times a minute.

• **The Glenn L. Martin Company** . . . Specifications for a new combination twin-engined trainer, staff-transport, and utility-cargo airplane have been presented to the U.S. Navy and Air Force. The basic mission of this ship, designated the Martin Military Airlift 4-0-4, is carrying 15,000 lbs. of cargo over a combat range of 1,500 miles at 270 m.p.h. One of the two envisioned versions of the Airlift 4-0-4 would be powered by conventional piston engines; the second by turboprop power plants.

• **The Parker Appliance Company** . . . The completion of molds and service stocks of AF 934 O-rings in all of the 101 new sizes added to the specification has been announced. The new additions bring to 189 the number of sizes now carried as AF 934 standard stock items by the company.

• **Piasecki Helicopter Corporation** . . . Personnel and plant facilities have been more than doubled during the past 12 months. Present plans call for doubling the plant area and personnel again during the coming year.

• **Pratt & Whitney Aircraft Division, United Aircraft Corporation** . . . A license to permit the Chrysler Corporation to build the J-48 Turbo-Wasp jet engine is being negotiated. Chrysler is scheduled to build the J-48's in a new plant to be constructed near Detroit.

• **Republic Aviation Corporation** . . . An undisclosed number of F-84 Thunderjet fighters will be built by General Motors Corporation in the Buick-Oldsmobile-Pontiac assembly plant at Kansas City, according to a licensing agreement drawn up between the two concerns. The F-84 is powered by an Allison J-35 engine.

• **A. V. Roe Canada Ltd.** . . . A thrust bearing that automatically adjusts itself to minor misalignments in the bearings of a rotating shaft has been developed for use in the Orenda gas-turbine engine. The bearing is mounted in a housing that holds it firmly to the shaft, the housing and the recess in the frame together forming an annular trough that is completely filled

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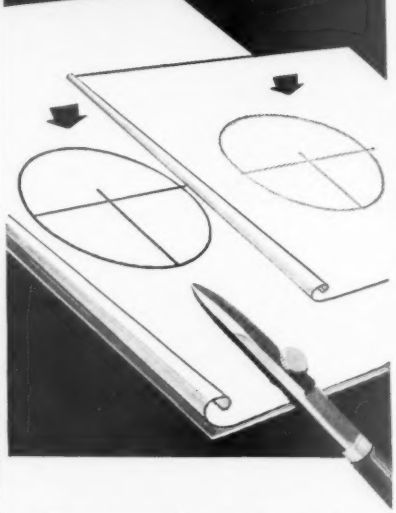

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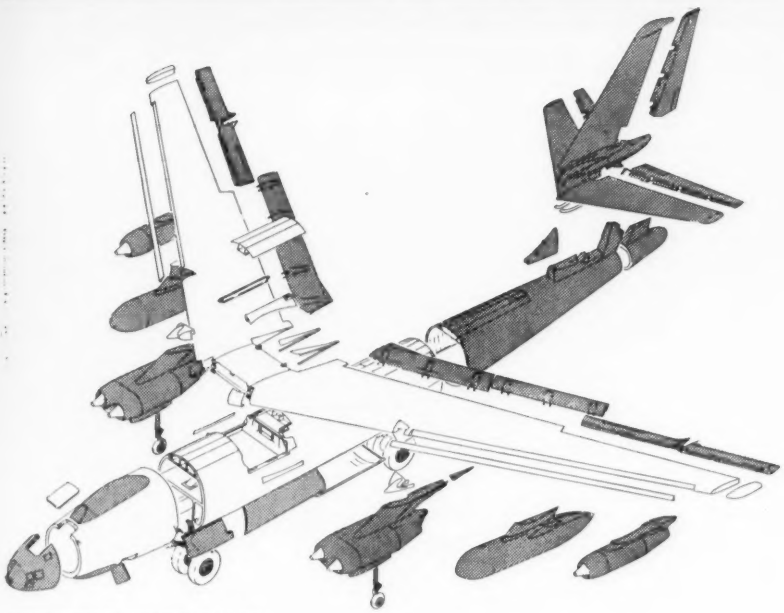


SUBCONTRACTED WORK

The shaded areas of this "exploded" production drawing of Boeing Airplane Company's B-47 Stratojet bomber indicate the subcontracted portions. Approximately 40 per cent of the B-47 air-frame cost is assigned to subcontractors. This work, plus outside purchases of parts and materials, amounts to a total 67.4 per cent of the air-frame cost on this U.S.A.F. project.

with an incompressible but deformable ring of plastic material on which the bearing floats. Any slight misalignment of the shaft is accommodated by deformation of the plastic ring . . . Many of the World War II Lancaster 919's are being converted in an accelerated program for various defense operational purposes both by Avro and by de Havilland Aircraft of Canada, Ltd. The bomber, built by Victory Aircraft, Avro's predecessor, is to serve as a trainer, as well as a maritime reconnaissance aircraft . . . Floor space of approximately 1,000,000 sq.ft. is being increased by over 50 per cent, and some 175 acres of property are being added to those 225 already owned.

• **Ryan Aeronautical Company** . . . A Navion L-17B liaison plane with Aerojet Jato Junior rocket-motor installation recently underwent service tests under the supervision of the Aircraft Section, Army Field Force Test and Evaluation Board No. 1. Average take-off distance under all types of rough-terrain conditions was found to be approximately 200 ft. at full gross load.

• **Trans World Airlines, Inc.** . . . International flight operations will be moved in the late spring of 1951 from its present quarters at LaGuardia Field to New York International Airport (Idlewild). Only transatlantic flight departures and arrivals will be affected by the transfer. Current domestic route operations on transcontinental services will continue as at present at LaGuardia Field . . . A program to equip Model 749 and 749A Constellations with jet exhaust systems has been undertaken. The jet exhaust system to be installed was developed by Lockheed Aircraft Corporation and will replace the present two-stack exhaust collector rings with rings having ten stacks. These ten smaller tubes will have a jet effect on the aircraft's speed and, it is claimed, will supply an additional 11 m.p.h. to the speed of the aircraft at operational altitudes . . . Ten new Model 1049 Super Constellations have been ordered from Lockheed Aircraft Corporation. Delivery to T.W.A. is scheduled for the Spring of 1952. The Super Constellations will be more than 18 ft. longer than the present Constellation and will have a gross weight of 120,000 lbs. They are to be designed and stressed for turboprop engines.

• **Westinghouse Electric Corporation** . . . A new plant for the production of small electric motors is to be built in Union City, Ind., according to a recent announcement. The new plant will be a modern one-story structure containing both manufacturing and office space. Production is expected to start late in 1951 . . . Also recently announced were plans for additional expansion of the Westinghouse Small Motor Division. Two buildings, totaling some 120,000 sq.ft. of floor space, have been leased. The larger building will be used to produce machined parts needed at the Company's main Lima plant for military production; the second building will be devoted to office and storage use. The Division's industrial sales and industrial engineering departments are now located at this second site . . . The U.S.A.F. has ordered $20,000,000 worth of electrical equipment for a new wind tunnel to test full-size jet engines, guided missiles, and wing sections and fuselages of aircraft. The wind tunnel is to be built at the Arnold Engineering Development Center, Tullahoma, Tenn. . . . A plant for the manufacture of Micarta is to be opened at Hampton, S.C. Operation is scheduled to begin early in 1951 . . . Micarta-gear-manufacturing know-how is offered to equipment manufacturers in a new 15-page Micarta-gear booklet.

INITIAL FLIGHT

The Convair-Turboliner, America's first turboprop transport, made its initial flight on December 29, 1950. The Turboliner is a research transport ordered by Allison Division, General Motors Corporation, to test their turboprop engines in commercial-type aircraft. This ship, a modified twin-engined Convair-Liner, is powered by two 2,750-hp. Allison 501 turboprop engines, known as T-38's for military planes. The propellers are entirely new-type four-bladed props, which were developed by G.M.C.'s Aeroproducts Division. A low-pressure, self-starting system, developed by AiResearch Manufacturing Company, Division of The Garrett Corporation, has been installed in the Turboliner and makes it possible for the pilot to start the engines an unlimited number of times, without supplementary ground power equipment, by simply pushing a button on the instrument panel.

Meet Your Section Chairmen

William T. Immenschuh

San Diego Section

William Taber Immenschuh's initial interest in the aeronautical profession was kindled when he was only a boy. It was his fashion then to watch T. Claude Ryan fly his early airplanes from the mud flats of San Diego. Young Immenschuh was soon an ardent adherent to the cause of aviation and waited only for the time when he might become more closely allied with it. That opportunity, the occasion of his first solo flight in 1935, came when he had been out of high school for 3 years. In the years that have elapsed since then, he has maintained his private pilot's status.

In 1938, Mr. Immenschuh matriculated at Ryan School of Aeronautics from which he was graduated in 1940. That was the year in which he bought himself an airplane. Employed by Ryan Aeronautical Corporation shortly after completing his course at the Ryan School, he has remained with the corporation. For the first 2 years of his employment, he was a draftsman. He was then made Group Leader and was concerned with fuselage, controls, equipment, and surfaces. In 1944, he became a Project Engineer, and for the next 6-year period (until September, 1950) he was responsible for the design and development of the Navy FR-1, XFR-4, and XF2R-1 "Fireball" series of fighter aircraft. His most recent promotion was this last September when he was appointed Executive Engineer and was made responsible to the Director of Engineering for the complete operation of the Engineering Department, including design, development, and testing.

Mr. Immenschuh writes us that "the most interesting episode in any engineer's career is the day the airplane he has worked hours, days, and months on first takes to the air. That is the thrill that erases all the delays, discouragements, and redesigns that go into an airplane before it is air-borne for the first time."

William Immenschuh was intimately concerned with the operation of the I.A.S. Building in San Diego from its embryonic stages, through its ultimate realization, to its recent leasing to Consolidated Vultee Aircraft Corporation. Although this obviously involved a considerable amount of his free time from his duties at Ryan, he nonetheless could be found there much of the time. His self-imposed tasks were manifold; they included dealing with the public, arranging for use of the building facilities for many types of functions; supervising the custodian, caterer, and librarian-secretary; leasing office space; and meeting with civic officials and aircraft-company managements.

In 1942, Mr. Immenschuh married Julia Watkins. They and their two children, a 6-year-old daughter and a 4-year-old son, reside in La Mesa, Calif. He is an ardent trout fisherman and has made a hobby out of scale-model railroads. He is a member of the Aircraft Owners and Pilots Association.

Carl V. Lindow

Toronto Section

Carl Victor Lindow, who celebrated his 27th birthday this last February 17, is currently Assistant Chief of Stress—Transports, A. V. Roe Canada Ltd. As such, he supervises the stress-analysis and structural - design groups of jet-transport design. He is also responsible for the arrangement and presentation of all technical and test data required for the certification of civil transports.

A native of British Columbia by virtue of having been born at Nelson, he received his secondary-school education in Salmo and Nelson, B.C. After completing high school in Nelson in 1942, he enrolled at the Spartan College of Aeronautical Engineering. Two years later, he was graduated from here as an Associate in Arts in Aeronautical Engineering and at that time was designated the recipient of the I.A.S. Student Branch Award for Scholarship.

His first employment was in 1944 with Noorduyn Aviation as a Technician for flight-test observation, aerodynamics, and stress analysis. In 1946, he left Noorduyn and joined Avro Canada as an Aerodynamicist on aerodynamic design, stability, and control.

The following year, he was made a Stress Analyst for wing structures. From 1948 to 1950, he became a Group Leader, supervising wing analysis and structural design. Last year, 1950, he was promoted to his present position.

Aviation in one form or another has been "in his blood" for many years. "At a very early age," he tells us, "I considered being a bush pilot or an airline pilot, the ultimate in professions; in later years the design end became more appealing as the desire to improve on existing airplanes was felt." But it took what he terms a "minor crash" to make "flying more eventful" for him. This was back in 1944 when a Tiger Moth airplane that he was landing on skis struck an obstruction hidden in the snow and resulted in "writing off the wings and landing gear." He received his Canadian Private Pilot's License in 1946 and now also holds a Radio Telephone Operator's License.

Mr. Lindow offers this: "Probably the most interesting episode in a stress man's professional career is seeing a full-scale structure fail catastrophically on test at just the right load. . . It makes the preceding years of work worthwhile."

Carl Lindow enjoys good hunting and fishing, especially when the hunting is in Northern Ontario and the fishing is in the Rocky Mountains of Alberta. His immediate family consists of himself; his wife, the former Josephine Moore whom he married in 1948; and his dog, a springer spaniel named Trixie.

I.A.S. Sections

Cleveland-Akron Section

Morris A. Zipkin, *Secretary*

The December 19 meeting was held at the Lewis Flight Propulsion Laboratory. The meeting was called to order by the Section Chairman, John H. Collins, Jr. Dr. Sharp, Director of the Lewis laboratory, acted as toastmaster for the evening. The guest speaker was Dr. William Bollay, Director, Aerophysics Laboratory, North American Aviation, Inc. Dr. Bollay repeated his Wright Brothers' Lecture, "Aerodynamic Stability and Automatic Control," for the benefit of the members and guests of the Cleveland-Akron Section. Dr. Bollay's presentation was followed by prepared discussions by Harry Goett, of the N.A.C.A. Ames Aeronautical Laboratory; Robert Mayne, of Goodyear Aircraft Corporation; and Aaron Boksenbom, of the Lewis laboratory.

The meeting was preceded by a social hour and dinner. Approximately 200 members and guests were in attendance.

Los Angeles Section

H. A. Storms, *Past-Secretary*

The November 16 meeting was called to order by the retiring Section Chairman, P. A. Colman. Following presentation of the annual report, Mr. Colman commented upon the success of several innovations during the past year, including the specialists' meetings, the informal evening socials, and the annual dance, and he recommended that these new activities be continued.

R. L. Schleicher, Membership Chairman, reported on the results of his committee activities, and Mr. Colman expressed appreciation to all retiring officers, committee members, and committee chairmen.

The new officers were introduced as follows: Chairman, F. A. Cleveland; Vice-Chairman, Dr. Allen E. Puckett; Secretary, Milton A. Miner; and Treasurer, E. B. Sporleder.

Mr. Cleveland, the new Section Chairman, then introduced the guest speakers for the evening: E. C. Frost, Preliminary Design Engineer, Lockheed Aircraft Corporation; E. A. Droegemueller, Project Engineer, Pratt & Whitney Aircraft Division, United Aircraft Corporation; and W. V. Handley, Assistant Manager, Aviation Division, Standard Oil Company of California.

All three speakers restricted their discussions to the subject of fuels derived from petroleum and to their use in civil aircraft. Mr. Frost showed how new fuels would benefit aircraft design from the aspects of economy, performance, and safety. Mr. Droegemueller followed with a discussion of desirable fuel characteristics as they affect aircraft engines, and Mr. Handley discussed the availability and probable cost of various types of fuel.

These interesting presentations were concluded with a general discussion period. Approximately 100 members and friends of the organization were in attendance.

New York Section

R. P. Harrington, *Secretary*

The third in this year's series of meetings was held on December 7. C. E. Pappas, Vice-Chairman, acted as general chairman of the meeting. The speaker, Dr. Nicholas J. Hoff, Head, Department of Aeronautical Engineering and Applied Mechanics, Polytechnic Institute of Brooklyn, was introduced by Dr. R. P. Harrington, who conducted the technical part of the meeting.

Dr. Hoff spoke on structural problems of future airplanes and pointed out that recent advances in structural design and analysis are rather meager in comparison with the development in aerodynamics and propulsion. This is particularly true in the case of extremely thin elements of airplanes destined to fly at supersonic speeds at elevated temperatures. He pointed out that our present concepts of lifetime and safety would have to be revised to cope with contingencies of supersonic flight. He showed the difference between the requirements for the subsonic and supersonic wings and how these have led to the replacement of the thin-walled monocoque by thick-walled structures. As a result of his calculations, he determined that the transient states of temperature distribution could cause dangerously high stresses and that steady-state high temperatures could lead to time-dependent deformations of nonpermissible magnitude. He believes that a rapid development in the method of structural design analysis is required in order to make full use of the present achievements in the fields of aerodynamics and propulsion.

St. Louis Section

Jack A. Durand, *Secretary*

The December 19 meeting was held at the Engineers' Club and was attended by 40 members. Chairman Don Berlin presided. There was a discussion of the possibility of having lapel identification badges. Mr. Flesh, of the Program Committee, presented comments that he had received from the New York office concerning the procurement of "outside" nationally known speakers. Professor Kippenhan, of the Membership Committee, distributed mimeographed forms to the members to be used for the recommendation of prospective I.A.S. members.

The speaker of the evening was Charles Wood, Chief Test Pilot, McDonnell Aircraft Corporation, who presented an enthusiastic and informative talk on "Helicopter—Rotary-Wing Aircraft." Mr. Wood, a graduate aeronautical engineer, entered the aviation industry in 1932 and, after working many years on all types of aircraft, was introduced to the helicopter in 1944. After flying one of the first Sikorsky helicopters for 28 hours over a 5-day period, he obtained one of the earliest helicopter licenses to be granted in the U.S.A. Mr. Wood told of some of the amusing, breathtaking, and dangerous incidents that happened to him in those early days of the helicopter at Floyd Bennett Field. His flight to an altitude of 12,000 ft. in a Sikorsky craft stood as a record at the time. Mr. Wood then presented a history of the rotary-wing aircraft, beginning with the early crude types and continuing down to the present-day experiments on ram-jet and rocket-type helicopters. Of interest was the material about the ram-jet helicopter of which McDonnell's "Little Henry" was the first flying prototype. Mr. Wood stated that tests have proved the suitability of ram-jet propulsion for all sizes of helicopters in that the ram-jet requires only a minimum of maintenance and no warm-up period. In quantity production, the cost of manufacturing the ram-jet would be small. Mr. Wood concluded with some outstanding feats that the helicopters were performing in the present Korean War and ventured to say that the helicopter would be the answer to many air lines for carrying passengers and freight in the future.

Following the talk, a colored, sound film on *Little Henry, Ram-Jet Helicopter* was shown.

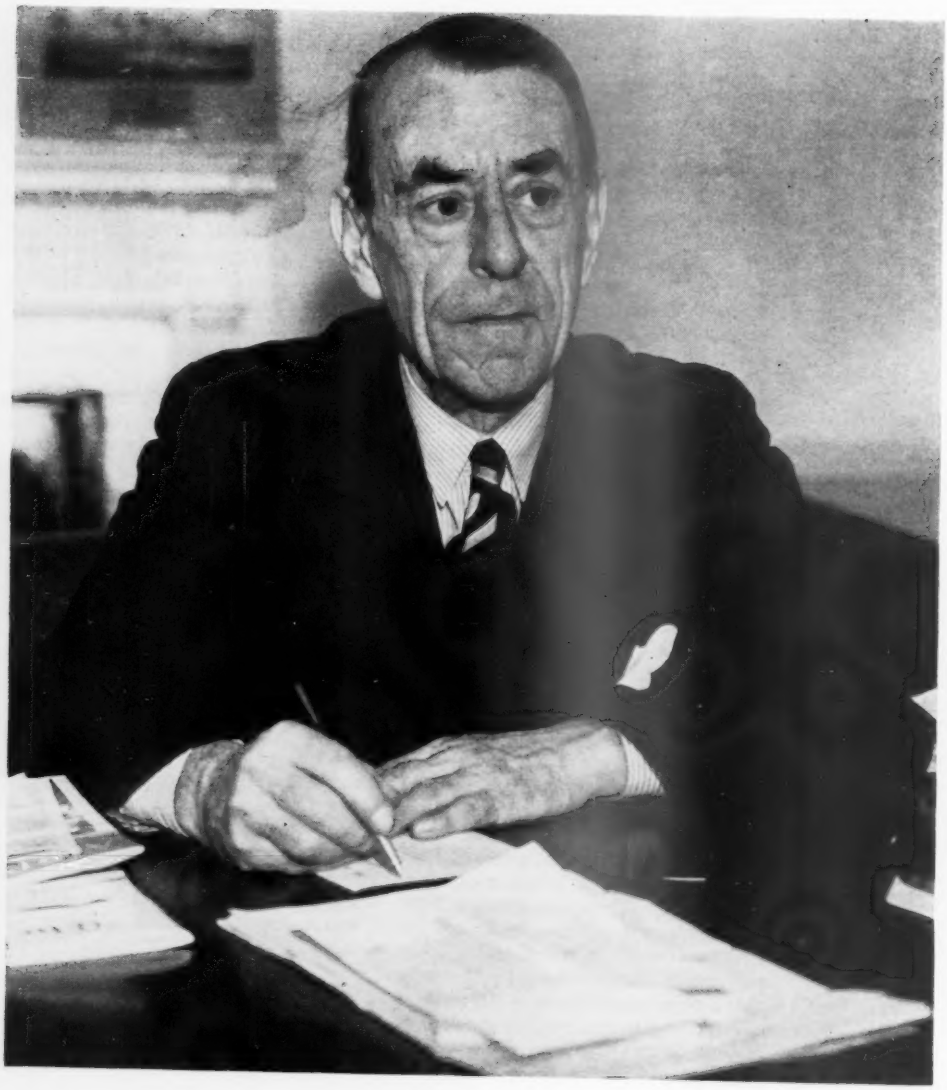
San Diego Section

W. H. Shutts, *Secretary*

On December 7, 72 members and guests attended a dinner meeting. Among those attending were several out-of-town guests who were in San Diego to participate in an aerodynamics panel meeting at Convair earlier in the week, as well as two aeronautical-engineering students from San Diego State College.

The speaker of the evening was J. E. Arnold, Chief Test Engineer in Charge of the Ordnance Aerophysics Laboratory. Mr. Arnold's talk consisted of a general discussion of this facility, its organization, and testing procedures.

(*Continued on page 96*)



Long-time Secretary of The Royal Aeronautical Society, Captain J. Laurence Pritchard.

Editorial

Visitor of the Week

Our Nineteenth Annual Meeting was marked by the presence of many distinguished visitors from overseas. We had in attendance, for example, a group of 15 top aeronautical scientists from the North Atlantic Treaty Organization, here for a series of conferences on aeronautical matters under the auspices of the U.S.A.F. There were a number of others from all over the world, but among them none was more welcome than our old friend and "opposite number" from The Royal Aeronautical Society, J. Laurence Pritchard.

We were all delighted earlier in January when Laurence cabled to say that it would be possible for him to pay us a visit during our meetings to discuss the detailed planning for the coming International Aeronautical Conference in September. His visit paid ample dividends in that connection, for we were able to settle many questions on the spot that might otherwise have been bothersome if discussed via transatlantic mail or cable. Shortly, we shall be able to advise Institute members of the exact plans for the meeting, the papers to be presented, and the programs that will surround the technical sessions.

Valuable as was that end of the business, we all felt that Captain Pritchard's visit marked another real milestone in the history of the relationship between the two leading aeronautical societies of the World. He is not only an old personal friend of many of us but he represents, and most ably, a group in Great Britain with whom it is of the utmost importance that we maintain a basis of common understanding. Some of us are inclined to think of the British as staid and standoffish, and many on their side of the ocean are convinced of the lunacy and general irresponsibility of Americans as a whole. The Secretary of The Royal Aeronautical Society is certainly one to dissipate such foggy notions of our opposite national characteristics. His sense of humor and his intensely human point of view instantly dispel any notion of British stuffiness, and his profound understanding of human behavior makes it possible for him to carry back to the other side (we hope) some notion that all Americans are not so crazy as they seem to be as viewed from the outside or as seen through our newspapers, Hollywood, or our radio and television shows.

All in all, his 10-day visit on this side of the Atlantic was tremendously worth while. We as individuals enjoyed as always our conversations with Laurence Pritchard, and we as a society profited greatly from the first-hand interchange of views with our British colleagues.

At the meeting of the Institute Council on January 31, a resolution was passed which has been transmitted by President Richardson to the President of The Royal Aeronautical Society. It so well sums up our collective feelings that it is worth while to quote here in full.

"*RESOLVED*, that the Officers and Council of the Institute of the Aeronautical Sciences send greetings to the Officers and Council of The Royal Aeronautical Society and express their great appreciation for the visit of your Secretary, Captain J. Laurence Pritchard, to discuss plans for the Third International Conference of the two societies. Our members are looking forward to renewing friendships with the members of The Royal Aeronautical Society and continuing the discussion of mutual aeronautical problems. We feel that the closest possible collaboration between the two societies is essential in this critical period of World history."

S. P. J.

Honors Night Dinner Address

by

THE HONORABLE JAMES E. WEBB
Under Secretary of State

The Honorable James E. Webb, Under Secretary of State.

"I NEVER CEASE TO MARVEL at the ingenuity and skill which attend the application of science to aeronautics. And I know that the future of this great nation, depending as it does on research and development, will be aeronautically safe among men devoted to the high ideals of this great Institute.

"To the layman, like myself, science is a wonderful and at the same time a fearful thing. We see the results of science in every phase of our richly diversified national life. In your own field of aeronautics it is a remarkable experience to take off in a modern aircraft in foul weather and feel absolutely sure there is no cause for concern. It is wonderful for an old-time pilot like me to sit in the cockpit and come in for a landing under full automatic control. You see the rudders move to change course, but no foot is there. You see the throttle move to keep air speed constant, but no hand is there. And you think back to that first time, before scientific instrumentation, when an undercast cut off your visual contact with mother earth and fear gripped your heart. You remember your first fledgling efforts to fly through a cloud, and the inevitable spin down out of it. You remember your first low visibility rule—go down where you can see the ground. And you remember also the thrill and relief of the new rule that came with the gyroscope—go up where there is nothing to hit.

"Eleven years ago, I stood before the aviation building at the New York World's Fair . . . , and watched the majestic departure of the first Pan American transatlantic commercial flight. A few weeks ago I flew the Atlantic at night and woke up the next morning to find that my plane was only one of 30 which crossed that same night.

"All this is progress. And we know that the work of Dr. Dryden and the other outstanding scientists whom we are met here to honor will soon take us far beyond what a short time ago may have seemed like the wildest of dreams. If there were nothing to interfere with the harnessing of this progress to the solution of the problems of a peaceful world, we could limit our discussion here tonight to the civil side of the accomplishments of aeronautical science. But the world is not peaceful and, therefore, the fearful side of aeronautical science—indeed of all science—is in the forefront of our consciousness.

"You in this Institute know the potentialities of present-day aeronautical weapons. You know they can penetrate to the most protected place to destroy man's most precious possessions. You know the dimensions of the fearful prospect of living in a world where such weapons are out of control. But what you can hardly appreciate is the difficulty faced by the political scientist, the expert in international affairs, and the political leader in the efforts they and we all must make to bring these weapons under effective international restraint. Without such restraint there can be no real confidence. Without confidence the institutions basic to our civilization cannot long exist.

"Every scientist here, I know, would rather devote his time and effort to the work of peace than to the work of war. But we live in a time when our need for power to restrain acts intended to destroy us means that the free world must rearm. It must rearm with

the most modern weapons, and it must stand together in the face of great danger. We and our friends must build military power that can become, in effect, a shield behind which we can carry forward the work of peace—the work of creating a cooperative international economic, political, and social system adequate to the needs of these times. In such a system the United States of America will seek no satellites. Our efforts will continue to be for a system based on international cooperation. Our deep desire is not for power *over* other nations. It is for power *together with* other nations and peoples.

"Now it has been my experience that scientists speak a more universal language and have more nearly universal habits of work and thought than other groups. Therefore it may be hard for you here tonight to visualize all the difficulties that flow from the adoption of the simple concept I have mentioned—that the free world must rearm and stand together. Not only different languages but also different forms of political organization and political thought are sizable obstacles. A major hurdle was passed 9 months ago. The North Atlantic Treaty nations, meeting in London, recognized that effective military power must rest on a more secure foundation than a plan to coordinate independent forces controlled by a number of nations. They adopted the concept of a balanced collective force to defend against aggression. Later, meeting in Brussels, they adopted the concept of an integrated European army. To make this concept a reality is the task now being spearheaded by General Eisenhower. It will be a part of your work, for a long time, to help him. You must invent new and better aeronautical weapons and mass-produce the ones already invented. When this is done, perhaps aviation and you can return to the work closest to your hearts—drawing the ends of the earth closer together in the work of peace.

"In solving the problems of collective security, the international political scientist cannot employ the precise techniques that you use in the physical sciences. He cannot set up in parallel five different projects to test five possible solutions. If he selects for his first effort the most promising one of the five and it proves a failure, he cannot then select a second and start it from the same base. In his field, every experiment starts from a new base. If the United States fails to ratify and support the League of Nations, the *status quo ante* cannot be restored a few years later. If our present efforts to create an integrated European army are not successful, an entirely different set of basic conditions will face us sometime in the future as we strive to build other institutions of collective security. But with all the difficulties, in spite of inability to precisely control and measure our experiments, real progress is being made. The science of political organization, the science of management of large affairs, is getting in its constructive work. . . ."

* * * * *

[NOTE: *The middle portion of Mr. Webb's address, which deals exclusively with the organization and function of the Department of State, has been omitted.*—ED.]

* * * * *

"Where does all this lead in our search for international cooperation as a foundation for world peace?

"First of all, we must recognize that the conduct of foreign relations includes many activities in addition to diplomatic negotiation. We have vital interests in all parts of the world. We are engaged in a number of very large, difficult, and expensive programs calculated to achieve foreign policy objectives. These programs must be effectively organized and administered.

"Second, the conduct of foreign relations is not only with individual nations but increasingly with groups of nations. Decisions on matters of foreign policy which ostensibly relate to one foreign nation cannot be made without considering their possible impact on other nations. Arrangements for such multilateral negotiation and cross-checking are essential.

"Third, we increasingly find that there is no clear line of demarcation between foreign affairs and domestic affairs. Participation in decisions and actions affecting the foreign field is required of many individual citizens as well as many Executive departments and agencies heretofore concerned almost exclusively with domestic matters. The Department of State must be prepared to provide coordination for these new and unaccustomed activities.

"Fourth, under our constitutional system, with its division of powers, the President has a large measure of responsibility in the conduct of foreign affairs. But the responsibilities of Congress are also broad. The Senate has jurisdiction over confirmation of appointments and over the ratification of treaties. The Congress has responsibility in policy formulation, the appropriation of funds, the regulation of foreign commerce, the fixing of import duties, and the declaration of war. In foreign policy development and implementation we must have close coordination of the Executive and Legislative branches.

"These four fundamentals are important to every citizen, and particularly to leaders of thought in the new fields like Aeronautical Science. In proportion as we recognize them and use energy, skill, perseverance, science, and faith to solve the problems they raise, we will speed up progress toward international cooperation and world peace.

"As I conclude, may I return to the thought with which I began—science is a wonderful and at the same time a fearful thing. As we, in the United States, join with other nations to put first things first and move urgently forward to build military power, let us never forget that there are international problems in this world which will remain when the threat of aggression is gone. The wonderful side of science will show itself full and complete when it can move on to help solve these postaggression problems. The end we must always seek is life, liberty, and the pursuit of happiness for all men everywhere."

Practical Aspects of Turbojets in Transport Aircraft

R. T. HOLLAND* and E. L. AUYER†
General Electric Company

IN STUDYING THE OVERALL SUITABILITY of the turbine-type engine for transport aircraft, it is well to evaluate some important practical considerations. Operating temperatures, noise, durability, service experience, and operating techniques are in this category. An analysis of practical considerations indicates that the major problems of the turbojet type of turbine engine have been solved. However, practical operating techniques for turbojet transport aircraft can be established only by the joint effort of operators, manufacturers, and Government under conditions of actual operation.

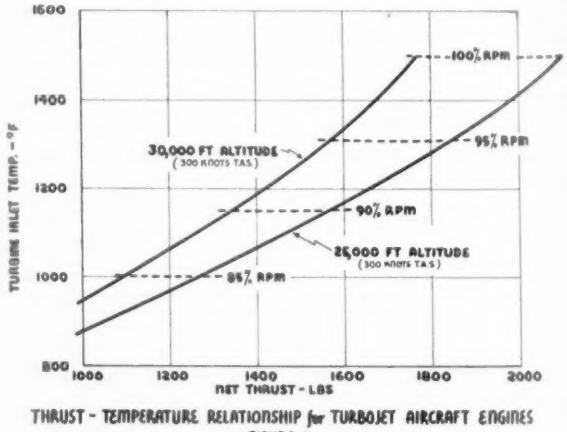
Having been developed for military purposes, existing turbojets have been and are being operated at high power levels that are relatively near the maximum permissible limits for a large percentage of their total operating time. Consequently, a great amount of attention has been focused on the subject of durability. This has resulted in rapid improvements in durability of the turbojet engine. However, severity of operation is a function of rate of accumulating engine time as well as operating power levels. Therefore, the high utilization rates achieved in transport operation will accelerate turbojet progress.

Other papers, presented in the past, have given the results of service experience on turbojet engines, and it is beyond the scope of this paper to present later information on service life. The service experience that has been obtained to date and the experience now being accumulated will be strong determining factors in the evaluation of turbine engines for transport aircraft.

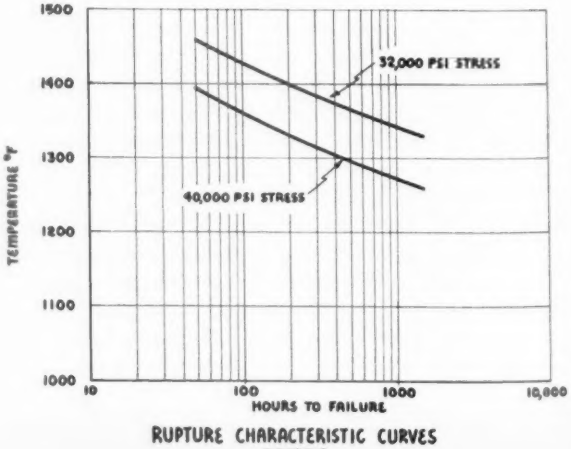
Consider how close to its maximum permissible limits the turbojet has been operated. For example, at cruise power, exhaust temperature and r.p.m.—the significant life parameters for turbojets—have been within about 90 to 95 per cent of the maximum permissible. Also, the time limit on the maximum permissible temperature and r.p.m. has been as long as one-half hour. As a bench mark, bear in mind that b.m.e.p.—an important parameter of the reciprocating engine—is generally used in transport operation at less than 75 per cent of the maximum permissible at equivalent operating conditions. Furthermore, for the reciprocating engine, the ratio of operating b.m.e.p. to maximum b.m.e.p. remains essentially constant with altitude; the simple turbojet has been operated nearer its maximum temperature and r.p.m. as altitude is increased. To realize fully the long life potential of the turbojet, therefore, designers must consider the desirability of a greater margin between maximum and normal continuous conditions.

Since turbine inlet temperature is an important criterion of severity of operation, a typical relationship is shown on Fig. 1. For the flight conditions given, it is seen that a 200°F. reduction in temperature produces a 12 per cent reduction in net thrust. This reduction is accompanied by about a 5 per cent reduction in r.p.m., so the 12 per cent thrust decrease is partially compensated by the less severe temperature-r.p.m. condition.

The importance of temperature is apparent when its effect on material strength is examined. Fig. 2 shows the familiar stress-rupture curves for stainless-steel



THRUST - TEMPERATURE RELATIONSHIP for TURBOJET AIRCRAFT ENGINES
FIGURE 1



RUPTURE CHARACTERISTIC CURVES
FIGURE 2

Presented at the Flight Propulsion Session, Nineteenth Annual Meeting, I. A. S., New York, January 29–February 1, 1951.

* Application Engineer, Aircraft Gas Turbine Divisions.

† Air Design Engineer, Aircraft Gas Turbine Divisions.

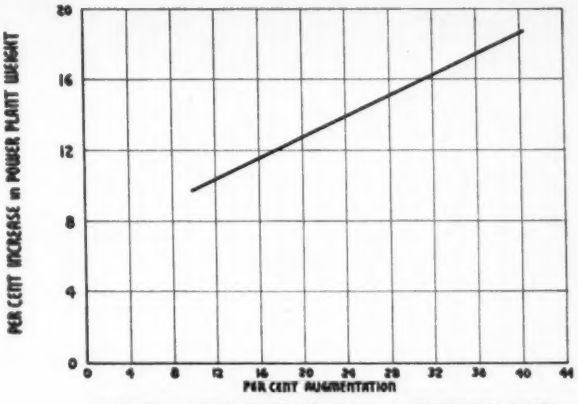
materials used in the hot-gas parts of turbine engines. The absolute values that are shown do not represent any specific material. The slope of the curves, however, is typical, and a great increase in hours to failure results from a relatively small decrease in temperature. These data are the result of laboratory pull tests on material, and no attempt is made to relate these data to the life of parts in actual operation; the logarithmic increase of the "hours to failure" is significant in itself. For instance, a tenfold increase in hours is obtained with a reduction of 100°F. material temperature.

Selection of engine size is usually approached by obtaining an engine that produces its minimum specific fuel consumption (s.f.c.) at the thrust that coincides with the most desirable cruising thrust requirements of the airplane in question. With existing turbojets this then produces rather long take-off distances, and the designer is then forced to seek higher thrusts for take-off in order to reduce the take-off distance. If this is achieved by going to a larger engine, range is usually reduced because most existing types of turbojets will then be operating at specific fuel consumptions substantially above their minimum s.f.c. It is desirable, therefore, for designers to consider matching compressor and turbine components of the larger engine required for take-off so as to favor low s.f.c. at the relatively low levels of output at the cruising condition. If this were ideally accomplished, the range reduction would only amount to the fuel weight equivalent of the weight increase due to the larger engine. Because of the reduced operating temperatures and r.p.m. for cruising, important gains in durability should result, and the larger engine would provide the desirable reliability margin that has been characteristic of transport application.

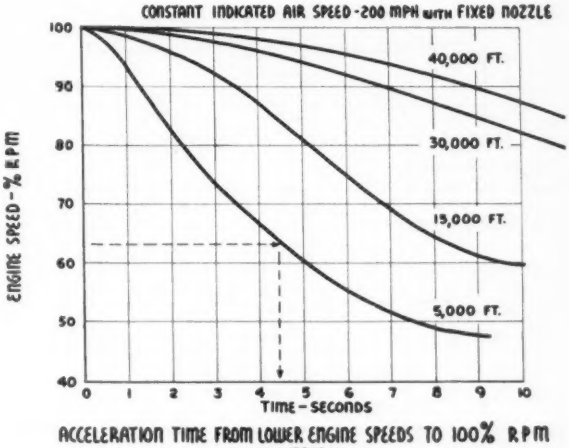
Various other methods of achieving take-off thrust have received wide attention; water injection, afterburning, and combinations of both have been considered. These methods are appealing because of the large per cent augmentation that is obtainable for relatively small weight increases. Afterburning, if designed for take-off only, need not introduce losses when operating in the cruise condition. The augmentation required for take-off can be achieved with afterburning at the expense of added noise at take-off, higher tailpipe temperatures, and a somewhat higher degree of complexity than is necessary with an unaugmented engine.

It is apparent that the final selection between a larger engine (operating at low power for cruise) and an engine fitted with afterburner is a compromise between the increased weight—but better durability of the larger engine—and the added noise, complexity, and weight due to the afterburner.

With regard to weight, Fig. 3 indicates roughly the relationship between per cent weight increase due to augmentation versus per cent augmentation for an afterburner designed for take-off. These data reflect the use of rather low-pressure-ratio compressors and are not necessarily representative of the effect upon high-



INCREASE IN POWER PLANT WEIGHT DUE TO AFTERBURNER PARTS
FIGURE 3



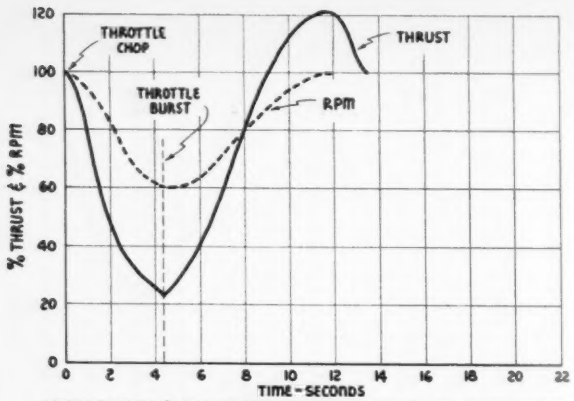
ACCELERATION TIME FROM LOWER ENGINE SPEEDS TO 100% R.P.M.
FIGURE 4

pressure-ratio machines. Fluid injection is not represented here, although it would find its application in the low augmentation percentages.

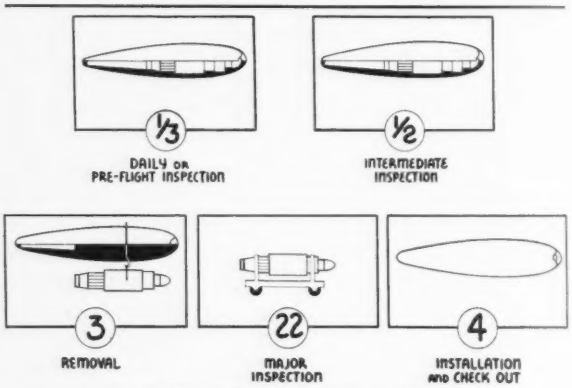
These weights include weight of afterburner, pumps, valves, controls, and hardware that are attributable to the afterburner part of the engine; fuel is not included. Since there is a fixed weight increase due to afterburner parts, this curve would not go to the origin but would level off at about the 8 per cent weight figure.

If it is assumed that a 25 per cent larger engine would produce 25 per cent more thrust, it is seen that this 25 per cent thrust increase could be achieved on a smaller engine by afterburning with only a 14 per cent increase in weight. Without considering fuel consumed during take-off or tankage space, it may be said that for this difference between 14 per cent and 25 per cent the greater noise, complexity, and higher tailpipe temperatures of the afterburning engine must be accepted; a compromise is desirable.

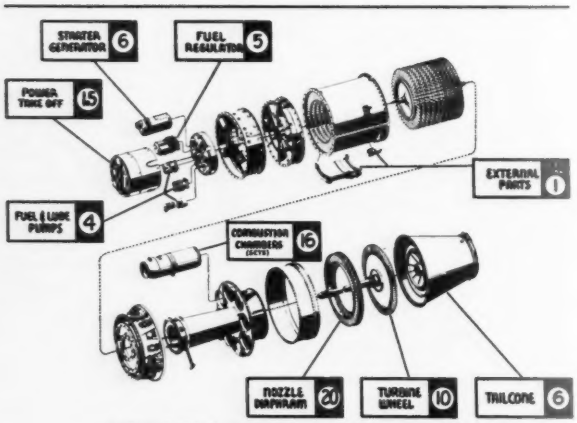
An additional avenue is open to the designer in applying engines to a specific airplane. Total take-off thrust required can be obtained with any combination of numbers of engines. Although, for transport aircraft, four engines appear to be the optimum number for reliability and symmetry, there is indication that a larger number of engines could be considered. In



DECELERATION & ACCELERATION-SEA LEVEL FLIGHT COND-FIXED NOZZLE
FIGURE 5



MANHOURS REQUIRED for MAINTENANCE
FIGURE 6



MANHOURS REQUIRED for PARTS REPLACEMENT
FIGURE 7

effect, this is the use of an additional "booster" unit for take-off and certain critical régimes. This introduces shutting down and relighting engines in flight. The relighting and restarting characteristics of existing turbojets are such as to provide flexibility of operation at most optimum conditions, and engines can be shut down to provide this flexibility. Relighting has become an accomplished fact for altitudes considerably above any altitudes contemplated for transport aircraft.

Control systems for turbojets have progressed to the point where a high degree of reliability without complexity has been obtained, and they are entirely adequate for transport operations. Coupled with a high degree of refinement, existing turbojet controls, as applied to the simple cycle engine, produce excellent stability and compensation under all flight conditions. Fig. 4 shows the acceleration time for the simple turbojet equipped with hydraulic controls that fully protect the engine and permit accelerations without overtemperature or overspeed. The time required to recover r.p.m. on existing turbojets is considerably longer than has been the practice in transport operations. With a two-position nozzle, these times could be reduced by one-third. It should be noted that in actual operation, with a fixed nozzle, the thrust recovery rate is higher than that indicated by the r.p.m. increase. This is because an increased exhaust gas temperature is encountered during acceleration. In fact, certain control schedules provide a thrust overshoot that is not usually factored into performance calculations but has been a source of reassurance to pilots.

Fig. 5 is a time history for a typical deceleration and acceleration characteristic of the simple turbojet with fixed nozzle. These curves, of course, do not reflect the result of engine characteristics upon the airplane, and there is increasing evidence that the actual effect on the airplane is related to pilot techniques.

Maintenance characteristics of turbojets are becoming more clearly defined, and Fig. 6 indicates the man-hour requirements for a typical nacelle-type installation. With the nacelle in the condition shown in the small diagrams, the preflight and postflight inspections require about $^1/_3$ man-hour per engine; intermediate inspections require about $^1/_2$ man-hour per engine; removal from the nacelle requires 3 man-hours; and with the engine removed, as required for a major inspection, about 22 man-hours are required for such inspection. Reinstallation of the engine requires approximately 4 man-hours including check-out. As crews become trained and installations become more refined, fast turn-arounds are indicated.

Fig. 7 shows the typical replacement times for various parts of the turbojet engine. These figures are based on the assumption that the engine has been removed from the nacelle.

With the high utilization rate anticipated in transport operation, overhaul becomes an important part of direct operating costs. Therefore, a number of studies have been made in an attempt to define the elements of costs that go into overhaul. A major element, of course, is the man-hour requirement for overhaul. Some estimates indicate 500 hours; others are below 200 hours. The best estimate for the General Electric TG190 appears to be between 280 and 300 man-hours. Overhaul, as used here, is defined as the uncrating; disassembly of the engine and accessories; preliminary inspection of parts; cleaning, plating, and painting; detailed parts inspection; rotor balancing; test and assembly of accessories; reassembly of engine; engine testing; and preparation for shipment. The cost of parts replacement, of course, is a function of service life, and, as

mentioned before, this subject is covered in the technical literature.

Variation between engines is a vital concern of the engine quality control people and has some bearing on operational factors. On large samples, the variation experienced is of a random type due to some extent to the requirement for parts interchangeability. Fig. 8 shows the type of variation that would be expected on a statistical basis. Data for this curve was obtained on engines that were not selectively assembled; selective assembly could reduce variation with some expense.

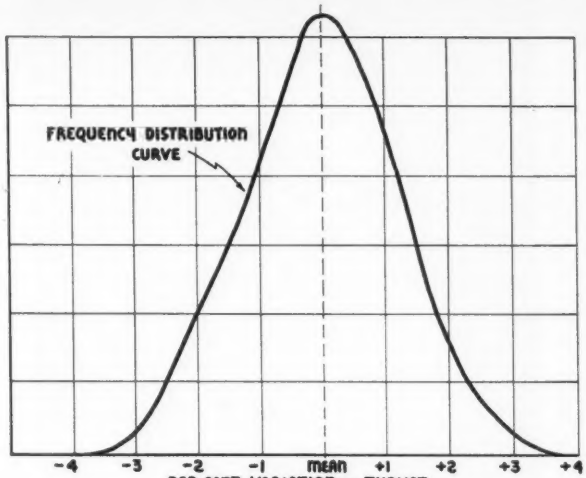
Since its inception, the noise problem associated with turbojets has received considerable attention from the public, as well as from industry. Noise control at test facilities has shown some excellent results, but noise control on an installation appears to be impractical. Since absolute measurements are always subjected to question because of variation in methods of measurement and interpretation, as well as variations between individuals concerning discomfort encountered, it is well to compare a known familiar noise with the new unknown noise.

The public is generally familiar with the noise level associated with conventional aircraft as the aircraft passes overhead. Therefore, noise measurements on the ground were made as a piston-engined aircraft passed overhead and also as a turbojet airplane passed overhead. Identical methods and measuring equipment were used for both tests, and both types of aircraft were operated at normal cruise power settings. The results, as shown on Fig. 9, indicate that noise levels for the turbojet were actually much lower than the noise levels of the piston aircraft. In addition, the ground observer is subjected to the turbojet noise for only 20 sec., while the piston aircraft noise persisted above background level for 70 sec.; in both cases, the aircraft were flown directly overhead at an altitude of 1,000 ft. The same pattern existed for the test made at 5,000 ft.

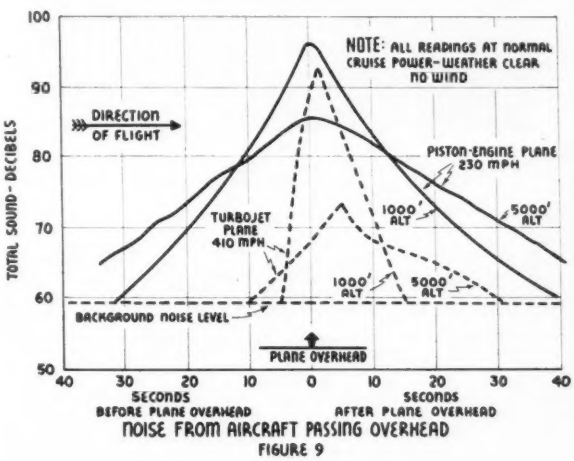
Measurements made about the aircraft while running engines on the ground indicate a significant difference in the shape of the sound pattern. The piston aircraft produces maximum intensity in the plane of the propeller, while the turbojet produces maximum intensity at 45° from the centerline of the jet wake for distances less than 400 ft. from the airplane. The angular location of maximum intensity increases as the distance from the airplane is increased; measurements made directly aft of the engine were surprisingly low. These results tend to confirm theory that the sound waves are refracted away from the centerline of the jet wake because of the temperature gradient across the wake.

Parking and taxiing procedures, therefore, may be different from those used for conventional airplanes, but it is felt that the noise level will have no adverse effect upon the acceptance by the public of the turbojet transport.

A review of the practical aspects of turbojets for transport aircraft indicates that the technical problems



VARIATION BETWEEN ENGINES
FIGURE 8



NOISE FROM AIRCRAFT PASSING OVERHEAD
FIGURE 9

are well in hand and that extensive service experience has been, and will continue to be, accumulated by the military services on this type of turbine engine. It is now necessary to arrive at practical solutions to the operational problems that are purported to exist. These operational problems can be evaluated and methods arrived at only by an actual operation with participation by transport operators, manufacturers, and Government. The simple turbojet of today is entirely adequate for such a testing and evaluation program.

It is important that the rich experience the operators have had in evaluating aircraft and power plants be brought into the high-speed transport picture as soon as possible. National regulatory authorities by their own participation would be assisted in their formulation of new regulations for turbine aircraft. The experience so gained would certainly accelerate the refinement of advanced turbojets now under development for the military services. The combined results will ensure a maximum gain to the future of military and civil air transportation in the United States by moving more tonnage faster with fewer aircraft.

Grover Loening, winner of the 1950 Wright Brothers Memorial Trophy.

The Engineering Approach

1903–1973

By
Grover Loening

To those of us who were privileged to know Wilbur and Orville Wright personally and who were lucky enough to be associated with them, their striking personal attributes share an equal place with their achievements in the art, science, and practice of inventing and flying the first successful airplane.

Their realism, fearlessness, and practical engineering approach to the problems they were going to solve were qualities that were accompanied by a search for truth, application of truth, and the practice of unusual mental honesty—qualities that are all too rare today, particularly in the highest quarters of our confused civilization. In these qualities, the brothers were much alike—outstanding and inspiring. In other ways they differed from each other. Wilbur had a practical, realistic, and business-like approach. Orville was more the engineer, scientist, and the idealist. To these characteristics must be added the patient persistence that they both had. As a result, the world was given in these two men an example to follow and look up to on the highest pinnacles of fine character.

We honor this day as the anniversary of flight, but in this propaganda-ridden era of half-truths, twisted-truths, and garbled misrepresentations on so large a scale, what a welcome breath of fresh air there is in the contemplation of the simple, direct, and honest purpose of the lives of these two men!

Fortunately for us there are requirements for aviators which, in themselves, tend to breed similar characteristics. An aviator, alone in the far reaches of the sky, is master of his own destiny more completely than in almost any other human activity, and to him the recognition of truth and its practice is essential to his life. So he soon learns that he better have it. He also carries with him a grave responsibility of having in his hands the destiny of many others were he to mishandle the mechanism that has been entrusted to him.

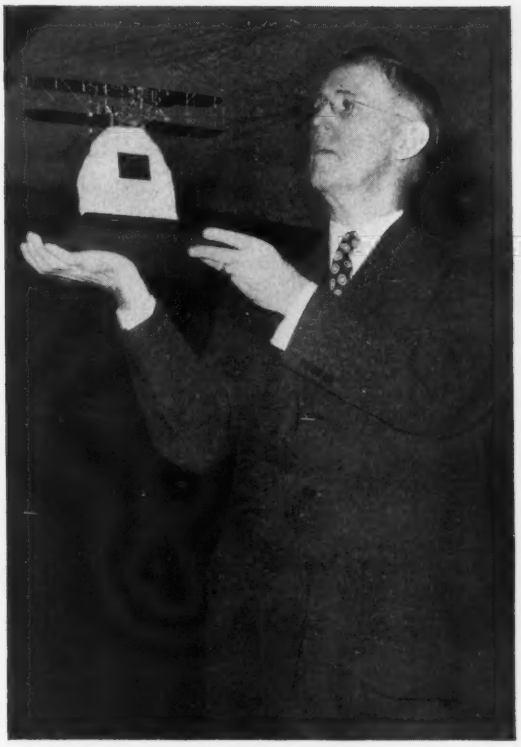
* * * *

The aviation business 40 years ago was so small that the total personnel engaged in aircraft manufacturing did not number much over 300 people in this country. Today, we have well over 300,000 directly in the aircraft and engine factories and as many more in allied lines of supply; of course, at our peak of production in 1944, there were several millions. Naturally, when we get to such a size, we lose perspective that we can regain only by halting for a moment in our breathless pace to appraise truthfully our deficiencies and then see where the future is likely to lead us.

The original Wright plane that went into production—the Model B—had a high speed of 42 m.p.h., carried two people, and had little over 2 hours' gasoline supply and a service ceiling at full load of about 8,000 ft. Also, it landed at about 29 m.p.h. and could be almost dived at the landing spot because the head resistance was so high that little speed was picked up. Today, 40 years later, we have a high speed 15 times as great (600 m.p.h.), ceilings of 50,000 ft., enormous gas capacity, but—and this is a big but—landing speed of three or four times as much.

In this higher landing speed may be found our first failure to improve the airplane through these many years. As a result of this failure, we have saddled the aviation business, both civil and military, with the impractical real-estate-expense burden of huge airports, with constantly present hazard on landing, increasing headaches on stacked-up traffic, and discouraging limi-

From an address at the Aero Club of Washington's Wright Day Dinner, December 16, 1950, at which time Mr. Loening received the Wright Brothers Memorial Trophy for 1950.



The Trophy, displayed by John Victory, Chairman, Wright Brothers Memorial Trophy Committee.

tations on wide personal use of aircraft as evidenced by the decline in private flying.

In that first early generation that I witnessed, history shows how slow and stupid we were in failing to take up more quickly and eagerly the tractor propeller type, the simpler and faster monoplane, all-metal construction, amphibians, wheel brakes, variable-pitch propellers, wing landing flaps, and closed cockpits. All of these features were being presented for years and yet few were interested.

In this second generation, from 1930 to 1950, we have been equally blind and stubborn in not vigorously taking up air-cargo development (even with Berlin and Korea to jolt us); in not pushing the helicopter and its "convertible" version not only for war but for short haul in commerce; in not realizing the new implications in jet-engine seaplanes when ski-equipped; in not developing control forces other than by movable flaps; in not providing gust-load alleviation both for the safety of the airplane's hard-strained structure and the comfort of the airsick passenger; in not developing various devices, including induced airflow, to slow the fastest plane way down for landing; and in not providing simple crashproof protection in cabins for personnel. Also, how slow we have been to realize that its outrageous noise makes the airplane anything but a good neighbor!

In research we have done well, opening up many new paths, although too many are for war only and cannot be disclosed.

However, summing up, the 1970 airplane may look like this. It may cruise at 1,200–1,500 m.p.h.; may be externally much quieter; may land almost vertically; may be built largely of titanium; may have an auxiliary engine for taxiing; may have its controls effected by airflow (rather than flaps, because of the slow speed requirement); may have a landing gear suitable for either land, water, or snow; may have variable sweepback; may incorporate gust-alleviation structure and seat springs to take the heavy air bumps at high speeds; may have fewer instruments for the pilot and many more automatic operations; and, above all, may be fireproof in crashes.

This means Europe in 3 hours, California in 2 hours, and Florida in 45 min. and also means landings on much smaller areas, even roofs, and in far greater numbers. Weather as a hindrance will have disappeared, just as high wind today has no effect on operation and yet caused flying to be called off in 1910.

To accomplish these results, however, and to keep ahead of the rest of the world, we must give utmost encouragement to the young engineer with new ideas and recognize that old men and reactionaries are also present in aviation and are a greater drag than in other fields because air progress moves so fast. We must also preserve competition, particularly in research; in fact we must demand it, otherwise talent will wither under the too authoritative eye of the commanding officer. Above all, we must not draft promising technicians and take them away from that essential life stream of technical production to be killed in a front line because technical production to protect them failed.

In 1928, the air lines of the United States carried only 48,000 passengers. In 1949, they carried 16,000,000. In 1970, they will carry an enormous traffic—particularly if we can solve this landing problem. On the shorter distances between great cities, the present use of schedules will probably be superseded by a

(*Continued on page 102*)

Colorado University's Steam-Jet-Powered Supersonic Wind Tunnel

TWO RECENT MASTERS' THESES in Aeronautical Engineering at the University of Colorado describe the design, construction, and calibration of a continuous flow steam-jet-powered supersonic wind tunnel of approximately 4 sq.in. test-section area. The work was directed by Prof. K. D. Wood, Head of the Department of Aeronautical Engineering, with the advice and assistance of Dr. H. W. Sibert and Prof. Franklin P. Durham. The theses are by William H. Shutts, now at San Diego State College, and Claude E. Waddell, now with the Aerodynamics Group, San Diego Division, Consolidated Vultee Aircraft Corporation.

The wind tunnel was built in order to provide a supersonic testing facility for student laboratory work and classroom demonstrations. The general arrangement was at least partly inspired by the N.A.C.A. Langley Field demonstration connected with the N.A.C.A.-University Conference of several years ago. The selection of power plant and most other details were dictated largely by local needs and availability of services and materials. The use of a steam-jet exhauster for power was suggested by Walter R. Woodward, of the Bell Aircraft Corporation. An investigation of the local conditions in Boulder, Colo., revealed that the University's steam heating plant was used to capacity only a small per cent of the time and that large amounts of steam could be available at small expense at practically all times except cold winter mornings. Economy was a major consideration, since the funds were supplied from an aeronautical equipment fund at this state university. A special study was made of costs, particularly with a view to the possibility of participating in Federal aeronautical research appropriations such as the so-called "Unitary Wind-Tunnel Plan" involving somewhat larger funds, larger tunnel test section, and more accurate test data.

A schematic diagram of the wind tunnel as designed by W. H. Shutts and constructed and tested by C. E. Waddell is shown in Fig. 1. Provision was made for later installation of a drier using "Sovabead" dessicant and steam regeneration. To the surprise of the investigators it was found that satisfactory schlieren photographs could be obtained in a tunnel of this size without drying the air, partly, perhaps, because the Colorado air is normally unusually dry. The authors are not familiar with any other supersonic wind tunnels that can operate without the use of a drier, but it is expected that even in Colorado a drier would normally be necessary in a larger size tunnel.

It is shown in Fig. 1 that the air passes first through some damping screens, through a contraction section (which could be shortened to good advantage), then through the supersonic nozzle and test section (locations 4 and 5), through a transition section and diffuser (sections 6 and 7), and thence to the intake of a Schutte-Koerting No. 8S3 steam-jet exhauster, such as is normally used for operating condensers in steam power plants. The mixture of steam and air is exhausted through the wall and through an outdoor muffler at the roof level of the building. The resulting noise level on nearby streets is only slightly greater than that due to steam exhaust from other engineering equipment. The noise level in the laboratory is high during the starting period but becomes considerably quieter after supersonic speeds have been reached, because the noise from the jet exhauster is not transmitted upstream through the intake at supersonic speeds.

A major feature of the tunnel design is the provision for quick change of nozzles and models. A number of different tests and demonstrations can be made in one 50-min. period. Observations are made optically and

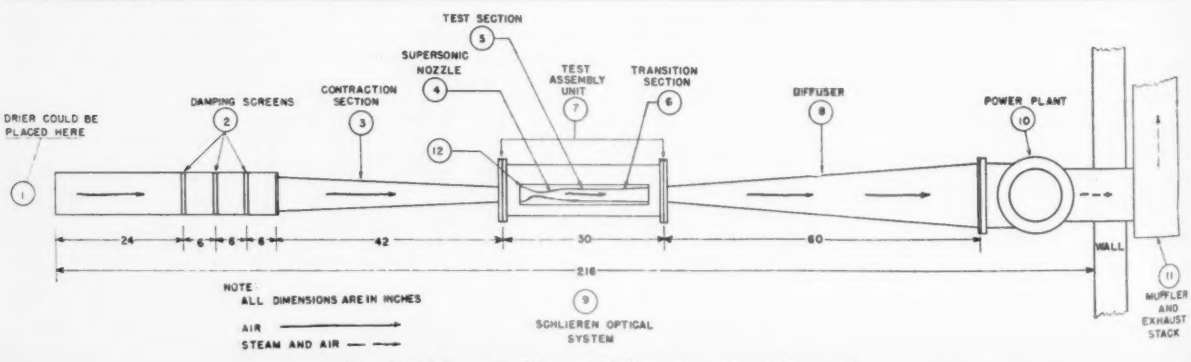


FIG. 1. Schematic diagram of the supersonic wind tunnel.

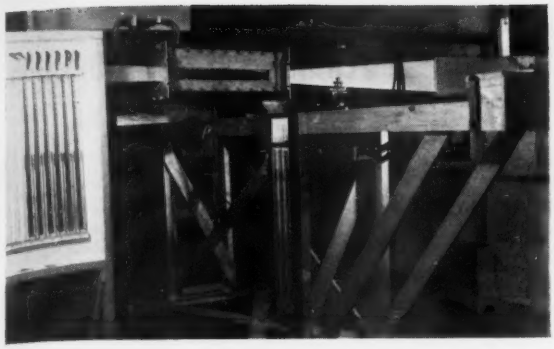


FIG. 2. Overall view of the supersonic wind tunnel showing the carriage supporting the schlieren optical system.

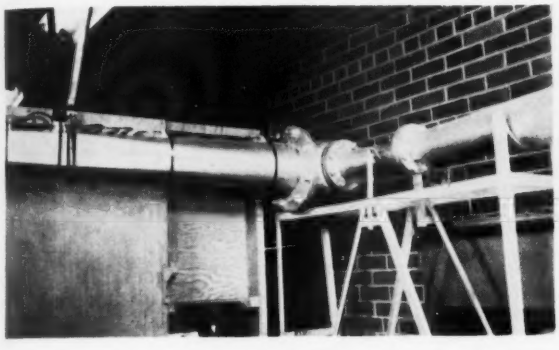


FIG. 3. Rear view of tunnel showing the diffuser and the steam-jet exhauster.

from manometer pressures, no balance system having been provided as yet.

An overall view of the supersonic wind tunnel showing the carriage supporting the schlieren optical system is seen in Fig. 2. The light source of the optical system is a General Electric A-H6 Lamp rated about 1,000 watts and water-cooled. The schlieren system uses 6-in. diameter mirrors of 72-in. focal length ground to a surface accuracy of 1/10 wave length of sodium light. A system of plane mirrors is used to project the schlieren image either into a camera or onto a screen that can be observed by a group of as many as 30 students or visitors. Fig. 3 is a rear view of the tunnel showing the diffuser and the steam-jet exhauster. Fig. 4 is one of the test-section assembly units with connections to manometers for measuring the upper wall-surface pressures. The sides of the unit, including the area near the throat of the nozzle, are made of ordinary plate glass. Sealing between the glass and the maple nozzles is by rubber tape. Although the assembly shown in Fig. 4 does not have a model mounted in the test section, various models have been mounted and tested.

Fig. 5 shows the interior arrangement of the test-section assembly, including the manometer connections and two adjusting nuts located, respectively, at the throat and test section to compensate for boundary-layer development.

(*Continued on page 108*)

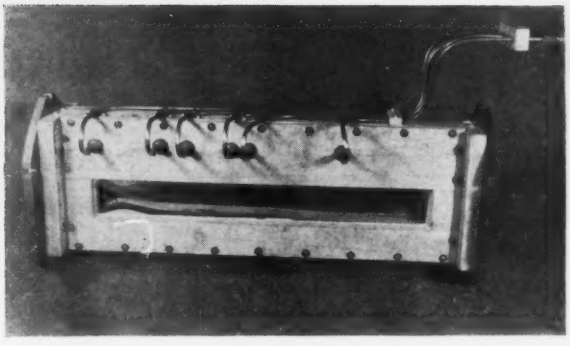


FIG. 4. Test-section assembly unit.

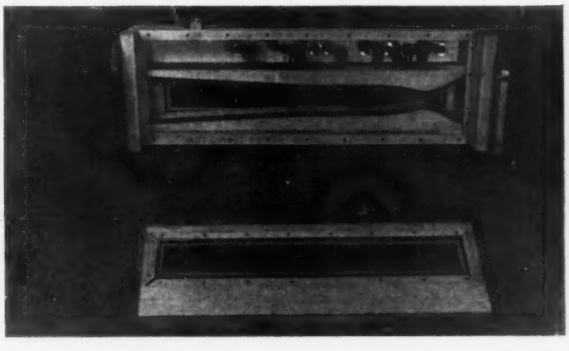


FIG. 5. Photograph showing the interior arrangement of the test-section assembly.

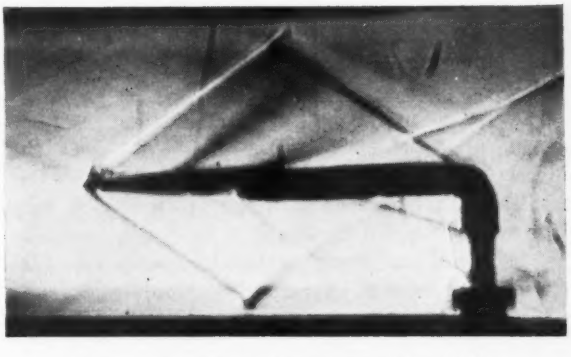


FIG. 6. Flow past a single wedge, $M = 2.02$.

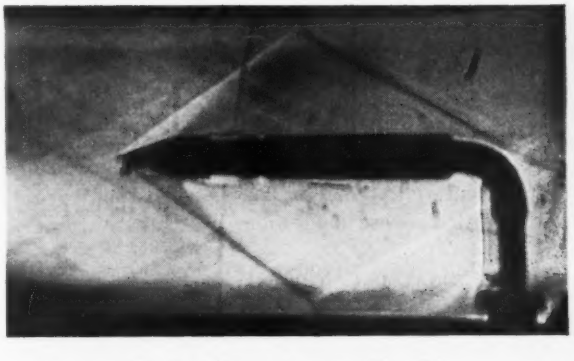


FIG. 7. Flow past a cone, $M = 2.1$.

Interaction Curves for the Critical Loads on Continuous Beam-Columns

EARL ROTTMAYER*
United States Naval Postgraduate School

SUMMARY

Interaction curves have been prepared for the buckling loads on continuous beam-columns for three fundamental cases. With the aid of these curves it is possible to solve many tedious design problems by a simple and quick procedure. Some typical design problems are discussed and illustrated by numerical examples. This same method could be extended to other cases of interest to the designer.

INTRODUCTION

IN THE ANALYSIS OF CONTINUOUS BEAM-COLUMNS, many questions arise concerning the buckling loads. It must be established, for instance, that the buckling load has not been exceeded when calculating the unknown support moments, since the calculations are of such a nature as to yield finite moments even after the critical loads have been exceeded. The margin of safety with respect to various combinations of axial loads may be desired. In the initial design stages the minimum moments of inertia to preclude buckling may be wanted.

All of these problems may be solved by standard methods. The calculations, however, are usually tedious and sometimes involve several trial solutions. These difficulties are a serious handicap to the designer.

The use of interaction curves offers the designer a convenient approach to these problems. Once the interaction curves are available, these and similar problems can be solved in a simple manner in very little time. Several applications to design problems are discussed and illustrated by numerical examples in the latter part of this paper.

Interaction curves have been prepared for three fundamental cases; they appear as Figs. 1, 2, and 3. Each case consisted of two spans. It was assumed that in each span the axial load and the bending stiffness were constant. The three cases are distinguished by their end conditions; these are: both ends pinned, one end pinned the other end fixed, and both ends fixed.

These three cases are, in themselves, of direct practical interest. They may also be used to determine limiting values for cases with other boundary conditions. Where interpolation of this nature is not sufficiently accurate, interaction curves could be prepared for the particular case in question.

DETERMINATION OF THE INTERACTION CURVES

The basic theory used to obtain the interaction curves is that given in reference 1, and the nomenclature is also the same except as noted in the text. The three-moment equation for continuous beam-columns may be written

$$M_1\frac{L_1}{I_1}\alpha_1 + 2M_{-2}\frac{L_1}{I_1}\beta_1 + 2M_{+2}\frac{L_2}{I_2}\beta_2 + M_3\frac{L_2}{I_2}\alpha_2 = \text{loading terms} \quad (1)$$

The solution to a problem in general consists of solving a system of equations of the form of Eq. (1). These may be written

$$\sum_{j=1}^{n} c_{ij}M_j = k_i \quad (2)$$

where M_j are the unknown support moments; k_i are the transverse loading terms; c_{ij} are functions of L, E, I, and P; and n is the number of unknown moments.

The critical loads are those that make the unknown support moments in the above equation infinite. A necessary condition that these moments be infinite is that the determinant of the c's vanish. Since the c's are a function of the axial loads, then so is the magnitude of the determinant. There are many sets of loads that make the determinant of the c's vanish, but only the smallest of these sets is of physical interest. There is also the possibility that the numerator will be zero at the same loads that the denominator is zero. This indeterminate form may mathematically yield finite moments but must be dismissed because the numerator depends upon the transverse loading terms. This implies a delicate balance of the transverse loads which cannot be achieved in practice. Therefore, the physically critical condition is that which first makes the determinant of the c's vanish.

Applying this criterion to the three cases investigated (see Figs. 1, 2, and 3), the critical conditions were found to be:

Case 1.—Both ends pinned:

$$\beta_1 = -(a/b)\beta_2 \quad (3a)$$

Case 2.—One end pinned the other end fixed:

$$\beta_1 = (a/b)\theta_2 \quad (3b)$$

Case 3.—Both ends fixed:

$$\theta_1 = -(a/b)\,\theta_2 \quad (3c)$$

In Eqs. (3a)–(3c),

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$$a = \frac{L_2}{L_1}, \quad b = \frac{EI_2}{EI_1}, \quad \theta = \frac{\alpha^2}{4\beta} - \beta$$

The subscripts designate the span.

The important variable in the above equations is L/j. In this paper it was more convenient to use the square of this quantity and to represent it by K. Therefore,

$$(L/j)^2 = PL^2/EI = K \tag{4}$$

The interaction curves consist of a plot of K_1 vs. K_2 as determined by Eq. (3). In order to solve these equations, it was first found convenient to plot β and θ against K. Then, for Case 2 and a particular value of a/b, K_1 was assumed and β_1 taken from the curve. The required value of θ_2 was calculated by means of Eq. (3b), and K_2 was taken from the curve. Using K_1 as the ordinate and K_2 as the abscissa, a point on the interaction curve was established. This was repeated until sufficient points were obtained to define the curve. The final results are shown as Figs. 1, 2, and 3. It should be noted that in Fig. 2 the parameter a/b varies from 0 to ∞, while in Figs. 1 and 3 the range is from 1 to ∞. In the latter two cases, it is only necessary to interchange the two spans to complete the range because the end conditions are the same.

Applications

If the structure and loads are known, the margin of safety is found in exactly the same manner that aeronautical engineers usually find the margin of safety from interaction curves. It is only necessary to calculate the quantities K_1 and K_2 and to indicate this point on the proper curve. This point represents the applied loads. A point on the proper interaction curve represents the allowable loads. The relationship between these two points determines the margin of safety.

It should be emphasized that only the problem of stability has been considered, and, consequently, the margin of safety is with respect to the buckling loads only. Although interaction curves are ordinarily used to predict failure of the material, the curves presented herein should not be interpreted in this manner. The prediction of failure due to excessive stress is an entirely distinct problem from the one under discussion.

If only the axial loads and the spans are known and if it is desired to find the minimum bending stiffnesses to preclude buckling, the problem is not unique. A relationship exists between the bending stiffnesses, and a unique solution may be found for a particular ratio of stiffnesses in the following way: If the axial loads are continuously increased while their ratio is kept constant, then the plot of K_1 vs. K_2 will be a straight line passing through the origin. It will have a slope, m, of

$$m = K_1/K_2 = (1/ra)\,(b/a) \tag{5}$$

where $r = P_2/P_1$. The intersection of this line with the proper interaction curve—i.e., corresponding to the a/b assumed—is the required solution.

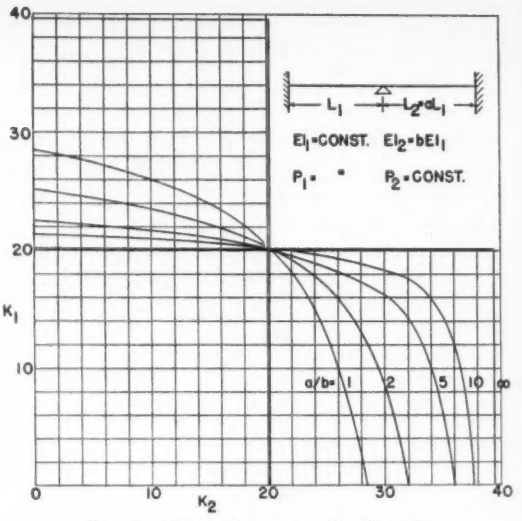

Fig. 1. Interaction curves for Case 1.

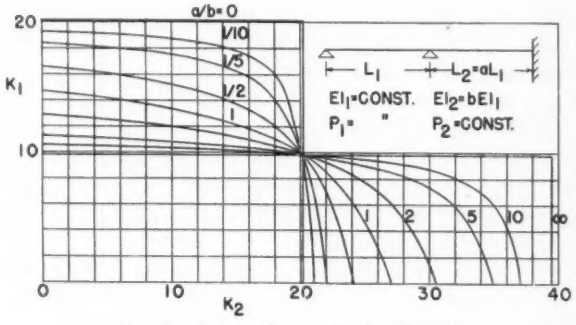

Fig. 2. Interaction curves for Case 2.

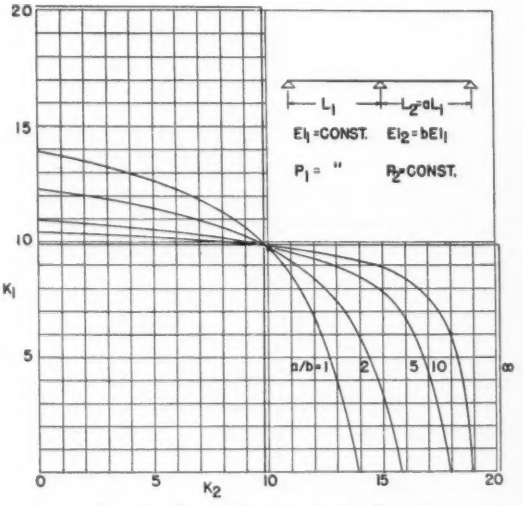

Fig. 3. Interaction curves for Case 3.

If everything is known except one of the bending stiffnesses, the problem is unique and may be found by the following procedure: Repeat the process described in the previous paragraph for several values of b. This will define a curve that will give solutions for this range of b. The intersection of this curve with the

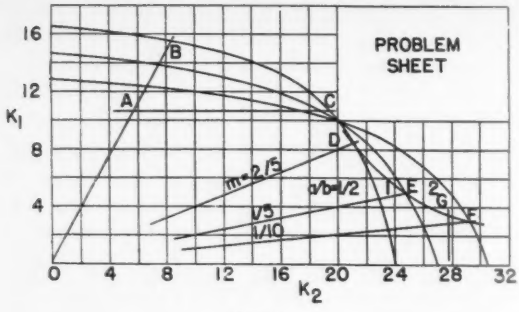

FIG. 4.

line K_1 = constant or K_2 = constant, whichever the case may be, is the required solution.

EXAMPLES

Each of the problems discussed above will be illustrated by a numerical example. The end conditions are assumed to be those of Case 2 for all problems. A part of Fig. 2 has been replotted as Fig. 4 to aid the explanation.

Problem 1

Given

$P_1 = 3{,}000$ lbs. $\quad P_2 = 3{,}200$ lbs.
$L_1 = 50$ in. $\quad L_2 = 50$ in.
$EI_1 = 7 \times 10^5$ lb.in.sq. $\quad EI_2 = 14 \times 10^5$ lb.in.sq.

Find the margin of safety.

The quantities required to enter the curve are

$$a/b = 1/2$$
$$K_1 = 3{,}000(50)^2/7 \times 10^5 = 10.7$$
$$K_2 = 3{,}200(50)^2/14 \times 10^5 = 5.7$$

The point corresponding to the applied loads is labeled A in Fig. 4. The margin of safety depends upon the manner in which the axial loads increase. If the ratio of the loads is constant, then the point B, on the $a/b = 1/2$ curve, represents the allowable loads. In this instance the margin of safety is

$$\text{M.S.} = (8.4/5.7) - 1 = +0.47$$

If P_1 remains constant while P_2 increases, then the point C represents the allowable loads, and the corresponding margin of safety is

$$\text{M.S.} = (19.5/5.7) - 1 = +2.42$$

Problem 2

Given

$P_1 = 2{,}000$ lbs. $\quad P_2 = 10{,}000$ lbs.
$L_1 = 50$ in. $\quad L_2 = 50$ in.

Find the minimum bending stiffnesses to preclude buckling.

Two of the ratios required for the calculations are:

$$a = L_2/L_1 = 1, \quad r = P_2/P_1 = 5$$

If it is assumed that $b = 2$, then $a/b = 1/2$. From Eq. (5) the slope is

$$m = (1/5)\,(2) = 2/5$$

The solution for this particular ratio of bending stiffnesses corresponds to point D in Fig. 4. The desired minimum bending stiffnesses are

$$EI_1 = \frac{2{,}000(50)^2}{8.4} = 5.9 \times 10^5 \text{ lb.in.sq.}$$
$$EI_2 = \frac{10{,}000(50)^2}{21.2} = 11.8 \times 10^5 \text{ lb.in.sq.}$$

Problem 3

Given

$P_1 = 2{,}000$ lbs. $\quad P_2 = 10{,}000$ lbs.
$L_1 = 50$ in. $\quad L_2 = 50$ in.
$EI_2 = 9 \times 10^5$ lb.in.sq.

Find the minimum value of EI_1 to preclude buckling.

In this instance the slope is equal to $(1/5)\,(b/a)$. The slopes are tabulated below for several values of a/b.

a/b	1/2	1	2
m	2/5	1/5	1/10

The possible solutions for this range of a/b are represented by the curve DEF in Fig. 4. The value of K_2 required is

$$K_2 = 10{,}000(50)^2/9 \times 10^5 = 27.8$$

The solution is represented by point G. This corresponds to an a/b of 1.6 and a K_1 of 3.4. Therefore, the minimum bending stiffness required to prevent buckling is

$$EI_1 = \frac{2{,}000(50)^2}{3.4} = 14.7 \times 10^5 \text{ lb.in.sq.}$$

REFERENCE

[1] Niles and Newell, *Airplane Structures*, 3rd Ed., Vol. II, p. 105; John Wiley & Sons, Inc., New York, 1943.

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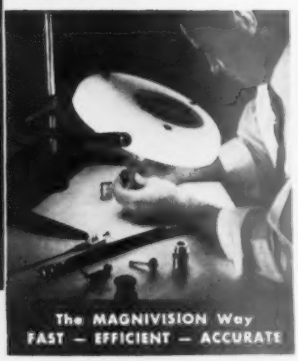

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Aerodynamics (2)

BOUNDARY LAYER

Stability of the Supersonic Laminar Layer with a Pressure Gradient. Lester Lees. *Princeton University, Aeronautical Engineering Laboratory, Report No. 167,* November 20, 1950. 39 pp., illus. 11 references.

Calculation of the approximate critical Reynolds Number (stability limit) for the boundary layer on insulated supersonic symmetric circular-arc airfoils at $M = 1.5, 2.0,$ and 3.0. Velocity and temperature distributions are computed by the Dorodnitzyn-Pohlhausen method based on the von Kármán integral equation.

Discussion: Some Experiments on the Interaction of Shock Waves with Boundary Layers on a Flat Plate, by F. W. Barry, A. H. Shapiro, and E. P. Neumann. Lester Lees, H. W. Liepmann, S. Dhawan, and W. A. Loeb. *Journal of Applied Mechanics,* Vol. 17, No. 4, December, 1950, pp. 461, 462. 2 references.

The Boundary-Layer and Stalling Characteristics of the NACA 64-010 Airfoil Section. Robert F. Peterson. *U.S., N.A.C.A., Technical Note No. 2235,* November, 1950. 16 pp., illus. 4 references.

Laminar Mixing of a Compressible Fluid. Dean R. Chapman. *U.S., N.A.C.A., Report No. 958,* 1950. 7 pp., illus. 9 references. U.S. Govt. Printing Office, Washington. $0.15.

A method is developed for calculating the velocity profiles in the mixing layer for a fluid with a Prandtl Number of unity. At Mach Numbers of 0, 1, 2, 3, and 5, velocity profiles are computed for both a linear and a 0.76-power variation of viscosity with absolute temperature.

Wind-Tunnel Tests for Temperature Recovery Factors at Supersonic Velocities. W. F. Hilton. *Journal of the Aeronautical Sciences,* Vol. 18, No. 2, February, 1951, pp. 97–100, illus. 4 references.

A study of the temperature attained by an unheated body moving at supersonic speeds. The rise in temperature is due to skin friction and adiabatic compression. Temperatures were measured on the surface of a tangential ogive attached to a cylinder of 4-in. diameter at Mach Numbers of 1.73 and 2.00. The model was made of Lucite.

CONTROL SURFACES

A Comparison of the Lateral Controllability with Flap and Plug Ailerons on a Sweptback-Wing Model Having Full-Span Flaps. Powell M. Lovell, Jr. *U.S., N.A.C.A., Technical Note No. 2247,* December, 1950. 22 pp., illus. 10 references.

A free-flight investigation to compare the dynamic lateral control characteristics on a model with 38° sweptback wing, an aspect ratio of 3.0, and a taper ratio of 0.5, at a C_L range from 1.0 to stall.

Hermes V Improvements; Introduction of Double-Slotted Flap to Increase Take-Off and Landing Weight. *Flight,* Vol. 58, No. 2184, November 30, 1950, p. 504, illus.

Readers' Forum: A Simple Graphical Solution of the Duhamel Integral. E. V. Laitone and J. T. Ahlin. *Journal of the Aeronautical Sciences,* Vol. 18, No. 2, February, 1951, pp. 142, 143, illus. 2 references.

FLUID MECHANICS & AERODYNAMIC THEORY

An Analysis of the Applicability of the Hypersonic Similarity Law to the Study of Flow About Bodies of Revolution at Zero Angles of Attack. Dorris M. Ehret, Vernon J. Rossow, and Victor I. Stevens. *U.S., N.A.C.A., Technical Note No. 2250,* December, 1950. 27 pp., illus. 6 references.

Pressure distributions computed by the method of characteristics for ogive cylinders for Mach Numbers and fineness ratios (both ranging from 1.5–12) were compared at zero angle of attack. The limits of Mach Number and fineness ratio for which the hypersonic similarity law holds were determined. Results indicate that the hypersonic similarity law applies over a wider range of Mach Numbers and fineness ratios than can be expected from the assumptions made in the derivation of the law.

On Non-Steady Motion of Slender Bodies. John W. Miles. *The Aeronautical Quarterly,* Vol. 2, Part 3, November, 1950, pp. 183–194, illus. 9 references. A solution is obtained for unsteady supersonic flow over very slender bodies of revolution and over wings.

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The Correction of Wind Tunnel Nozzles for Two-Dimensional, Supersonic Flow. R. W. Meyer and M. Holt. *The Aeronautical Quarterly*, Vol. 2, Part 3, November, 1950, pp. 195–208, illus. 6 references.

The flow in the wind tunnel is assumed to be two-dimensional, isentropic, irrotational, steady flow of a perfect gas. The corrections for the nozzle are expressed in terms of the values on the axis of the characteristic coordinates of the field of flow in the uncorrected nozzle.

Supersonic Flow Around Circular Cones at Angles of Attack. Antonio Ferri. *U.S., N.A.C.A., Technical Note No. 2236*, November, 1950. 30 pp., illus. 7 references.

Measurements of Diffraction of Shock Waves and Resulting Loading of Structures. Walker Bleakney, D. R. White, and W. C. Griffith. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 439–445, illus. 4 references.

Explanation of experimental methods of studying diffraction phenomena. Waves of large amplitude are generated in shock tubes. Interferograms are made both in the still air and in the disturbed flow, and contours of fringe shifts are plotted. The principal forces can be measured as a function of time, and the loading can be determined.

Discussion: Some Experiments on the Interaction of Shock Waves with Boundary Layers on a Flat Plate, by F. W. Barry, A. H. Shapiro, and E. P. Neumann. Lester Lees, H. W. Liepmann, S. Dhawan, and W. A. Loeb. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 461, 462. 2 references.

Erratum: Transonic Potential Flow of a Compressible Fluid. W. R. Sears. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, p. 1340.

A change in Y. H. Kuo's analysis of the stability of mixed potential flow, which was reported in the original paper, changes some of the conclusions originally given by W. R. Sears.

Theoretical Investigation of Transonic Similarity for Bodies of Revolution. W. Perl and Milton M. Klein. *U.S., N.A.C.A., Technical Note No. 2239*, December, 1950. 32 pp., illus. 10 references.

The solution for compressible flow past slender bodies of revolution is obtained by an iteration process and analyzed with respect to transonic similarity. The results are in approximate agreement with those of von Kármán in the region of the flow field not too close to the body, but, in the region of the body, a new similarity law is obtained. This new law appears to be applicable only to extremely slender bodies of revolution.

Calculation of Compressible Potential Flow past Slender Bodies of Revolution by an Integral Method. Milton M. Klein and W. Perl. *U.S., N.A.C.A., Technical Note No. 2245*, December, 1950. 54 pp., illus. 13 references.

On a Source-Sink Method for the Solution of the Prandtl-Busemann Iteration Equations in Two-Dimensional Compressible Flow. Keith C. Harder and E. B. Klunker. *U.S., N.A.C.A., Technical Note No. 2253*, December, 1950. 10 pp. 4 references.

Laminar Mixing of a Compressible Fluid. Dean R. Chapman. *U.S., N.A.C.A., Report No. 958*, 1950. 7 pp., illus. 9 references. U.S. Govt. Printing Office, Washington. $0.15.

A method is developed for calculating the velocity profiles in the mixing layer for a fluid with a Prandtl Number of unity. At Mach Numbers of 0, 1, 2, 3, and 5, velocity profiles are computed for both a linear and a 0.76-power variation of viscosity with absolute temperature.

A Comparison of Theory and Experiment for High-Speed Free-Molecule Flow. Jackson R. Stalder, Glen Goodwin, and Marcus O. Creager. *U.S., N.A.C.A., Technical Note No. 2244*, December, 1950. 68 pp., illus. 19 references.

A comparison of free-molecule flow theory with results of wind-tunnel tests on a transverse circular cylinder of 0.0031-in. diameter to determine the drag and temperature-rise characteristics. The model was constructed of butt-welded iron and constantan wires. Test conditions corresponded to a Mach Number range of 0.55–2.75 and Reynolds Number range of 0.005–0.90.

A Simple Interferometric Test for Conical Flow. J. H. Giese, F. D. Bennett, and V. E. Bergdolt. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1226–1231, illus. 8 references. Development of a test for conicity based directly on interferometer fringe shifts. The test is applied to data obtained from conical regions in flows about bodies in free flight.

One-Dimensional Flows of an Imperfect Diatomic Gas. A. J. Eggers, Jr. *U.S., N.A.C.A., Report No. 959*, 1950. 11 pp., illus. 21 references. U.S. Govt. Printing Office, Washington. $0.15.

Vibrational Relaxation Times in Gases. Wayland Griffith. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp 1319–1325, illus. 13 references.

Investigation of the relaxation times of gases by the steady-flow method. The velocity distribution is calculated by Southwell's relaxation method. The thermodynamics appropriate to the experiments is briefly reviewed, and the kinetic processes involved are explained from the physical standpoint.

The Virtual Mass of a Sphere Entering Water Vertically. Albert May and Jean C. Woodhull. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1285–1289, illus. 5 references.

Calculation of the virtual mass of spheres for the vertical entry of the spheres into water during that phase that immediately follows the actual entry (an air-filled cavity is attached to the sphere).

Shadowgrams of Spherical Missiles Entering Water at Supersonic Speeds. J. H. McMillen, R. L. Kramer, and D. E. Allmand. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1341, 1342, illus.

The Force Acting on a Body Moving Uniformly Through a Gas Containing Sound Waves. F. R. N. Nabarro. *Philosophical Magazine*, Vol. 41 (7th Series), No. 323, December, 1950, pp. 1270–1280, illus. 7 references.

An evaluation of the factors affecting the retarding force on a body traveling through a gas containing an isotropic distribution of sound waves. The retarding force is proportional to the area of the body, the energy density of the sound, and its velocity.

On Some Special Problems in Linearized Axially Symmetric Flow. Bertrand des Clers and Chieh-Chien Chang. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 127–138, illus. 7 references.

Readers' Forum: Aerodynamics of Blasts. L. Ting and H. F. Ludloff. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 143, 144, illus.

INTERNAL FLOW

Analysis of the Effects of Design Pressure Ratio per Stage and Off-Design Efficiency on the Operating Range of Multistage Axial-Flow Compressors. Melvyn Savage and Willard R. Westphal. *U.S., N.A.C.A., Technical Note No. 2248*, December, 1950. 33 pp., illus. 4 references.

Application of Radial-Equilibrium Condition to Axial-Flow Compressor and Turbine Design. Chung-Hua Wu and Lincoln Wolfenstein. *U.S., N.A.C.A., Report No. 955*, 1950. 30 pp., illus. 12 references. U.S. Govt. Printing Office, Washington. $0.25.

Compressibility Correction for Turning Angles of Axial-Flow Inlet Guide Vanes. Seymour Lieblein and Donald M. Sandercock. *U.S., N.A.C.A., Technical Note No. 2215*, December, 1950. 31 pp., illus. 9 references.

Characteristics of Irrotational Flow Through Axially Symmetric Orifices. Hunter Rouse and Abdel-Hadi Abul-Fetouh. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 421–426, illus. 15 references. Numerical determination of the flow characteristics by the relaxation method. The problem was investigated with an electrical-analogy technique and the Southwell process of relaxation.

Investigation of the Flow Through a Single-Stage Two-Dimensional Nozzle in the Langley 11-Inch Hypersonic Tunnel. Charles H. McLellan, Thomas W. Williams, and Ivan E. Beckwith. *U.S., N.A.C.A., Technical Note No. 2223*, December, 1950. 30 pp., illus. 1 reference.

Analytical Investigation of Turbulent Flow in Smooth Tubes with Heat Transfer with Variable Fluid Properties for Prandtl Number of 1. Robert G. Deissler. *U.S., N.A.C.A., Technical Note No. 2242*, December, 1950. 39 pp., illus. 11 references. Equations that are applicable to both the addition and the extraction of heat are derived for the prediction of the radial disturbances of velocity and temperature.

Laws of Flow in Rough Pipes. J. Nikuradse. (*Verein deutscher Ingenieure, Forschungsheft Nr. 361, Beilage zu Forschung auf dem Gebiete des Ingenieurwesens, Edition B*, Vol. 4, July–August, 1933). *U.S., N.A.C.A., Technical Memorandum No. 1292*, November, 1950. 62 pp., illus. 28 references.

Experiments on the turbulent flow of water in pipes of 25–100 mm. in diameter, 1,800–7,050 mm. in length, and of various de-

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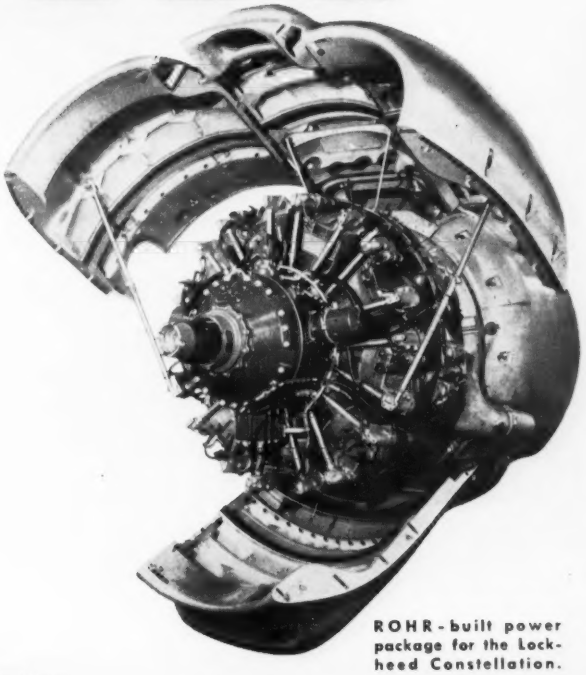

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grees of roughness. Flow velocity varied from $R = 10^4$ to $R = 10^6$. The flow laws of velocity distribution and flow resistance were determined as a function of R and the relative roughness.

Momentum and Mass Transfer in Coaxial Gas Jets. Walton Forstall, Jr., and Ascher H. Shapiro. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 399–408, illus. 89 references.

The mixing at constant pressure of a circular jet with an annular coaxial stream was studied for conditions of nearly common density and temperature, but differing initial velocities. By using 10 per cent by volume of helium as a tracer in the inner stream, the mixing region was mapped with respect to both material and momentum transfer. An extensive bibliography covers the most important analytical and experimental work related to the fields of mixing and jets.

Temperature Distribution in a Steady, Laminar, Preheated Air Jet. Chia-Shun Yih. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 381, 382. 2 references. Exact solution for the temperature distribution for the two-dimensional and axially symmetric cases.

The Diffusion of a Hot Air Jet in Air in Motion. II—The Flow Field in the Transition Zone. W. Szablewski. (*GDC/-2460*, September, 1946.) *U.S., N.A.C.A., Technical Memorandum No. 1288*, December, 1950. 92 pp., illus. 9 references.

Investigation with an Interferometer of the Turbulent Mixing of a Free Supersonic Jet. Paul B. Gooderum, George P. Wood, and Maurice J. Brevoort. *U.S., N.A.C.A., Report No. 963*, 1950. 16 pp., illus. 10 references. U.S. Govt. Printing Office, Washington. $0.20.

Investigation of a Systematic Group of NACA 1-Series Cowlings with and Without Spinners. Mark R. Nichols and Arvid L. Keith, Jr. *U.S., N.A.C.A., Report No. 950*, 1949. 100 pp., illus. 7 references. U.S. Govt. Printing Office, Washington. $0.55.

Studies in the Langley propeller-research tunnel of cowling-spinner combinations based on the N.A.C.A. 1-series nose inlets to obtain systematic design data for one family of approximately ellipsoidal spinners.

PARASITIC COMPONENTS & INTERFERENCE

Theoretical and Practical Data on Aerodynamic Drag. Sighard F. Hoerner. *U.S., Central Air Documents Office (Army-Navy-Air Force), Report No. F-TR-1196-IA (ATI No. 31168)*, August, 1950. 67 pp., illus. 44 references.

A study of the interference drag of bodies attached to walls, resulting from protrusions attached to three-dimensional bodies, induced interference drag on wings, and drag caused by the joining of wing and tail surfaces to the fuselage.

Remarks on Low-Aspect-Ratio Configurations in Supersonic Flow. P. A. Lagerstrom and M. E. Graham. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 91–96, illus. 10 references.

Simple low-aspect-ratio configurations are examined to obtain a qualitative understanding of wing-fuselage interference and afterbody effect of a missile; nonlinear and viscous effects are neglected.

Readers' Forum: On Supersonic Wing-Body Center of Pressure. G. K. Morikawa and T. F. Coleman. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, p. 140, illus. 2 references.

Readers' Forum: Base Pressures at Supersonic Speeds. J. Leith Potter. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 141, 142, illus. 4 references.

PERFORMANCE

The Estimation of Range of Jet-Propelled Aircraft. H. Pearson. *The Aeronautical Quarterly*, Vol. 2, Part 3, November, 1950, pp. 167–182, illus.

Simple method of estimating the maximum range of a jet aircraft under specific engine conditions applied to an aircraft of known characteristics. The engine factors involved in the estimation of aircraft range are reviewed.

Flight Characteristics at High Mach Numbers. V. Outman and G. S. Graff. *SAE Journal*, Vol. 51, No. 12, December, 1950, pp. 56–58, illus. (Excerpts from a paper.)

Flight on Asymmetric Engine Power. I. E. Wright. *Aircraft Engineering*, Vol. 22, No. 262, December, 1950, pp. 350–355, 374, illus. 5 references.

Flight in a multiengined aircraft when one or more engines has failed or stopped on a particular wing. The dangers involved under such flying conditions are explained; the methods of overcoming these dangers are evaluated and compared. Efficient handling of the aircraft in conditions of asymmetric power depends directly on the skill and knowledge of the pilot in flying and landing the aircraft.

A Method of Calculating the Landing Flare Path of an Airplane. Robert D. Fusfeld. *Aeronautical Engineering Review*, Vol. 10, No. 2, February, 1951, pp. 25–30, illus. 3 references.

The landing flare path is calculated by reducing the problem to that of a point mass moving in a plane with two degrees of freedom under the action of known forces. Formulas are derived for three types of motion in pitch.

STABILITY & CONTROL

Prediction of the Effects of Propeller Operation on the Static Longitudinal Stability of Single-Engine Tractor Monoplanes with Flaps Retracted. Joseph Weil and William C. Sleeman, Jr. *U.S., N.A.C.A., Report No. 941*, 1949. 20 pp., illus. 14 references. A method of computing power-on pitching moments based on power-off (propeller-off or windmilling) pitching-moment and lift data from wind-tunnel tests.

Addendum to Report I.18 on the Complex-Frequency Method of Stability Analysis. B. E. Swire. *Australia, Department of Supply, Aeronautical Research Laboratories, Report No. I.18 Addendum*, July, 1950. 9 pp., illus.

Corrections to the original report. A better design is suggested for the automatic-control instrument for pilotless aircraft which was originally reported.

Readers' Forum: Airplane Pitching Moment of Inertia. Innes Bouton. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 140, 141. 3 references.

THERMOAERODYNAMICS

Calculation of Thermal Stresses in a Wedge-Shaped Wing. George H. Eisenhardt and Warren M. Rohsenow. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 115–123, illus. 2 references.

Derivation of procedure for computing the thermal stresses of a solid symmetric double-wedge steel wing at an altitude of 50,000 ft., at a Mach Number of 1.4, and with a temperature distribution of 531.6°F. absolute. The wedge is subjected to uniform acceleration at a rate of one Mach Number per 30 sec. at $M = 1.4$–6.0. Thermal stresses are calculated on the wing at $M = 6.0$ and on the wing root, which is solidly built into the fuselage.

Wind-Tunnel Tests for Temperature Recovery Factors at Supersonic Velocities. W. F. Hilton. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 97–100, illus. 4 references.

A study of the temperature attained by an unheated body moving at supersonic speeds. The rise in temperature is due to skin friction and adiabatic compression. Temperatures were measured on the surface of a tangential ogive attached to a cylinder of 4-in. diameter at Mach Numbers of 1.73 and 2.00. The model was made of Lucite.

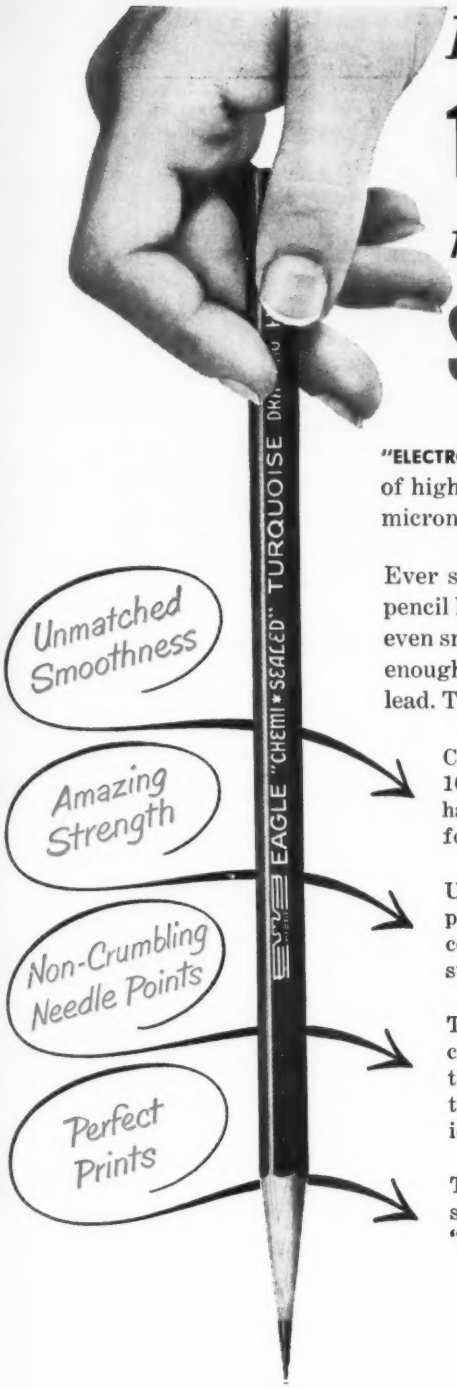
WINGS & AIRFOILS

Remarks on Low-Aspect-Ratio Configurations in Supersonic Flow. P. A. Lagerstrom and M. E. Graham. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 91–96, 100, illus. 10 references.

Simple low-aspect-ratio configurations are examined to obtain a qualitative understanding of wing-fuselage interference and afterbody effect of a missile; nonlinear and viscous effects are neglected.

Formulas for Source, Doublet, and Vortex Distributions in Supersonic Wing Theory. Harvard Lomax, Max A. Heaslet, and Franklyn B. Fuller. *U.S., N.A.C.A., Technical Note No. 2252*, December, 1950. 35 pp., illus. 7 references.

A review of the formulas in linearized wing theory. The source, doublet, and vortex distributions are related to the pressure and to the vertical induced velocity in the plane of the wing.



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The Effect of End Plates on Swept Wings at Low Speed. John M. Riebe and James M. Watson. *U.S., N.A.C.A., Technical Note No. 2229*, November, 1950. 60 pp., illus. 8 references.

Conical Flow Methods Applied to Uniformly Loaded Wings in Subsonic Flow. Seymour Lampert. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 107–114,138, illus. 5 references.

Calculation of the twist and camber of lifting surfaces of zero thickness. Conical flow solutions of Laplace's equation are used to obtain the pressure distributions of uniformly loaded lifting surfaces at subsonic speeds.

The Minimum Drag of Thin Wings in Frictionless Flow. Robert T. Jones. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 75–81, illus. 5 references.

Derivation of the conditions for minimum pressure drag on thin airfoils. The analysis is based on superimposing the disturbances in forward and reversed motion and is applicable only to flows with small disturbances. The analysis holds for steady and unsteady motion and subsonic or supersonic speeds.

Three-Dimensional, Unsteady-Lift Problems in High-Speed Flight—Basic Concepts. Harvard Lomax, Max A. Heaslet, and Franklyn B. Fuller. *U.S., N.A.C.A., Technical Note No. 2256*, December, 1950. 39 pp., illus. 12 references.

The build-up of lift on two- and three-dimensional wings at high speeds is investigated as a boundary-value problem for the classical wave equation. The application of Kirchoff's formula reduces the problem to a study of sources and doublets.

The Spanwise Distribution of Lift for Minimum Induced Drag of Wings Having a Given Lift and a Given Bending Moment. Robert T. Jones. *U.S., N.A.C.A., Technical Note No. 2249*, December, 1950. 14 pp., illus. 4 references. Evaluation of the induced drag of wings in subsonic flow.

Effects of Mach Number up to 0.34 and Reynolds Number up to 8×10^6 on the Maximum Lift Coefficient of a Wing of NACA 66-Series Airfoil Sections. G. Chester Furlong and James E. Fitzpatrick. *U.S., N.A.C.A., Technical Note No. 2251*, December, 1950. 43 pp., illus. 15 references.

The wing was tested in the Langley 19-ft. wind tunnel at two pressures. Mach Number range was from 0.10 to 0.34 and 0.07 to 0.26; the corresponding Reynolds Numbers ranged from 1.36 to 4.66×10^6 and from 2.20 to 8.00×10^6. Chordwise pressure distributions were measured on the model with full-span and partial-span flaps deflected at 60° and without flaps.

The Boundary-Layer and Stalling Characteristics of the NACA 64-010 Airfoil Section. Robert F. Peterson. *U.S., N.A.C.A., Technical Note No. 2235*, November, 1950. 16 pp., illus. 4 references.

Effects of Modifications to the Leading-Edge Region on the Stalling Characteristics of the NACA 63_1-012 Airfoil Section. John A. Kelly. *U.S., N.A.C.A., Technical Note No. 2228*, November, 1950. 22 pp., illus. 5 references.

Readers' Forum: On Supersonic Wing-Body Center of Pressure. G. K. Morikawa and T. F. Coleman. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, p. 140, illus. 2 references.

Delta Wing. Robert McLarren. *Aero Digest*, Vol. 61, No. 12, December, 1950, pp. 93–105, illus. 23 references. Review of the theory of the delta wing; the performance of delta-wing research aircraft.

Air Transportation (41)

Towards Slower and Safer Flying, Improved Take-Off and Landing, and Cheaper Airports. Frederick Handley Page. *Royal Aeronautical Society, Journal*, Vol. 54, No. 480, December, 1950, pp. 721–739, illus. 8 references.

Increases in aircraft speeds have increased take-off and landing runs that have made longer runways necessary and have raised airport operating costs. Suggestions to designers for reducing these disadvantages include high-life devices (boundary-layer control), improved undercarriage design, and reduction of minimum flying speeds.

Air Traffic Forecasting for the New York-New Jersey Port District. I. Alex L. Hart. *Journal of Air Law and Commerce*, Vol. 17, No. 4, Autumn, 1950, pp. 379–399. Adapted from the report, "Air Traffic Forecast, 1950–1980, New York-New Jersey Port District," prepared for the Port of New York Authority.

Wanted: Aircraft Loading Positions. Richard E. Stockwell. *Aviation Age*, Vol. 14, No. 6, December, 1950, pp. 20, 21, illus.

The problems involved in airport landing space are discussed on the basis that airport ramp congestion will increase with the inauguration of navigation aids to all-weather flying.

Air Coach. Hugh Harvey. *Shell Aviation News*, No. 149, November, 1950, pp. 14–17, illus. The history of air-coach service in the U.S.; problems of equipment, routes, and passenger reaction.

The "Air Coach" Experiment and National Air Transport Policy. II. Harold A. Jones and Frederick Davis. *Journal of Air Law & Commerce*, Vol. 17, No. 4, Autumn, 1950, pp. 418–435. 16 references.

Identification of Air Mail Subsidy and Its Effect on Airline Communities. Edward C. Sweeney. *Journal of Air Law & Commerce*, Vol. 17, No. 4, Autumn, 1950, pp. 459–468. 2 references.

Operational Requirements; Automatic Reservations Equipment. *Aeronautical Radio, Inc.*, 1949. 7 pp.

United States Overseas Air Cargo Services. IX. N. W. Kendall. *Air Transportation*, Vol. 17, No. 6, December, 1950, pp. 10, 32–34.

Major Airlines Profit; Non-Scheds Show Loss ATB Analysis Reveals. *Canadian Aviation*, Vol. 23, No. 12, December, 1950, pp. 22, 24, 52. Analysis of the economic situation of Canadian civil aviation for 1950.

Airplane Design & Description (10)

Towards Slower and Safer Flying, Improved Take-Off and Landing, and Cheaper Airports. Frederick Handley Page. *Royal Aeronautical Society, Journal*, Vol. 54, No. 480, December, 1950, pp. 721–739, illus. 8 references.

Increases in aircraft speed have increased take-off and landing runs that have made longer runways necessary and have raised airport operating costs. Suggestions to designers for reducing these disadvantages include high-lift devices (boundary-layer control), improved undercarriage design, and reduction of minimum flying speeds.

Aircraft Should Fit Airports. Alan Hepburn. *Aircraft*, Vol. 29, No. 2, November, 1950, pp. 30, 52, illus. Designers and manufacturers should standardize their aircraft so that existing or planned airport facilities would fit all types of planes in a particular class.

Utility-Command Craft for Army. *Aviation Week*, Vol. 53, No. 24, December 11, 1950, pp. 30, 31, illus. Proposal for a twin-engined transport aircraft for Army personnel transport and courier work which would be used in conjunction with the Cessna L-19.

A 70-Passenger Suction Wing? T. S. Keeble. *Aircraft*, Vol. 29, No. 2, November, 1950, pp. 26, 27, 42, illus. Results of tests with a Griffith GLAS II suction wing indicate the usefulness of this wing in the development of a 70-passenger flying-wing aircraft.

AIRPLANE DESCRIPTIONS

Airspeed Ambassador. V—Wing Centre-Section and Outer-Plane Tooling and Assembly. *Aircraft Production*, Vol. 12, No. 146, December, 1950, pp. 351–354, illus.

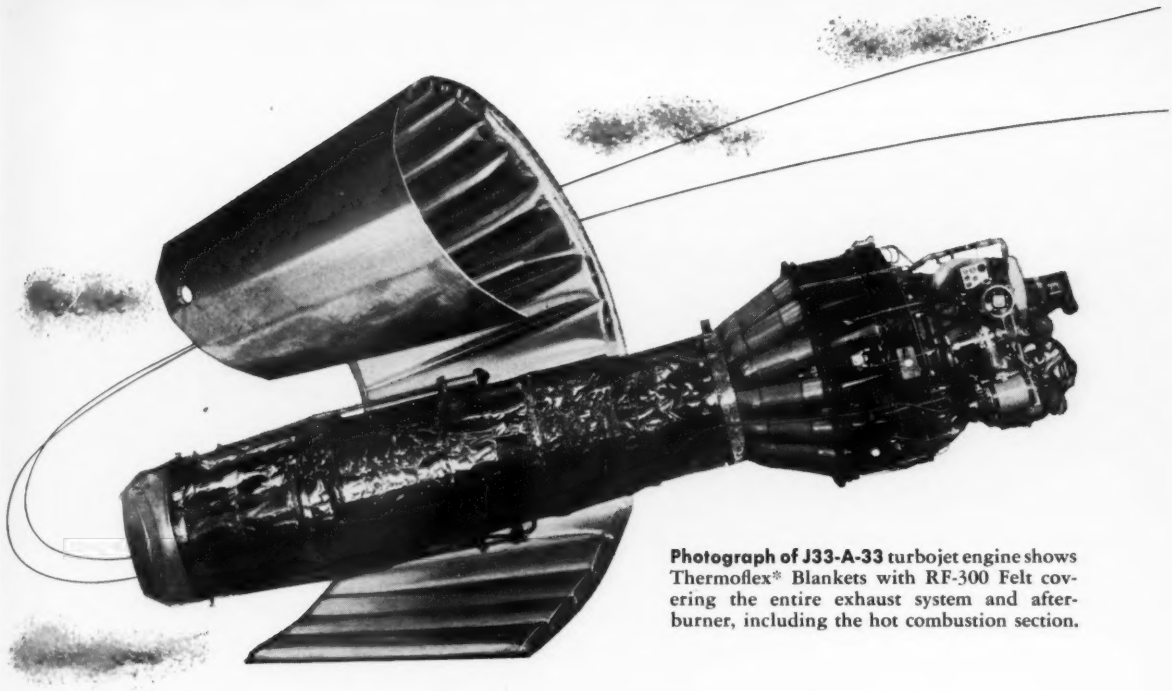
Anderson-Greenwood AG-14 Single-Engined Pusher-Type Personal Airplane. Ben Anderson and Marvin Greenwood. *Aeronautical Engineering Review*, Vol. 10, No. 2, February, 1951, pp. 31–36, illus. 3 references. Engine installation.

Anderson-Greenwood AG-14 Single-Engined Pusher-Type Personal Airplane. Leighton Collins. *Air Facts*, Vol. 13, No. 12, December, 1950, pp. 24–27, 30–32, 37–43, illus.

Avro Ashton Four-Engined Turbojet High-Altitude Research Airplane, England. *The Aeroplane*, Vol. 79, No. 2052, November 17, 1950, pp. 422–428, illus., cutaway drawing. *Flight*, Vol. 58, No. 2185, December 7, 1950, pp. 524–530, illus., cutaway drawings.

Chrislea Skyjeep 4-Place Single-Engined General Purpose Airplane, England. Derek D. Dempster. *The Aeroplane*, Vol. 79, No. 2057, December 22, 1950, pp. 572–574, illus.

de Havilland D.H. 115 All-Purpose Single-Engined Turbojet Trainer, England. *The Aeroplane*, Vol. 79, No. 2054, December



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JOHNS-MANVILLE JM PRODUCTS **Johns-Manville** **PRODUCTS for the AVIATION INDUSTRY**

1, 1950, pp. 485–490, illus., cutaway drawings. *de Havilland Gazette*, No. 59, October, 1950, pp. 4–7, illus.

Douglas Super DC-3 Twin-Engined Transport. Stanley H. Evans. *Aircraft Engineering*, Vol. 22, No. 262, December, 1950, pp. 356–360, illus.

Fairchild T-31 Single-Engined Basic Trainer (Aviation Design Progress). Randolph Hawthorne. *Aviation Age*, Vol. 14, No. 6, December, 1950, pp. 22, 23, illus., cutaway drawings.

Grumman F9F Turbojet Naval Fighter. *Aero Digest*, Vol. 61, No. 6, December, 1950, pp. 24–27, 62, 64, 66, 67, illus.

Helioplane 2 Personal Airplane. *The Aeroplane*, Vol. 79, No. 2054, December 1, 1950, pp. 478, 479, illus.

Lockheed F-90 Twin-Engined Turbojet Penetration Fighter. David A. Anderton. *Aviation Week*, Vol. 53, No. 26, December 25, 1950, pp. 27–29, illus.

Texas A. & M. Agricultural Airplane. *Aviation Week*, Vol. 53, No. 25, December 18, 1950, p. 32, illus.

Vickers-Armstrongs Viscount 4-Engined Turboprop Transport, England. *Engineering Journal*, Vol. 33, No. 12, December, 1950, pp. 1063–1066, illus. The Vickers-Armstrongs plant at Weybridge, Surrey; design and performance details of the Viscount.

COCKPIT & CONTROL CABIN

A Backward-Facing Seat Investigation; A Report on Studies by the Air Transport Command, Traffic Division, U.S.A.F. *Aircraft Engineering*, Vol. 22, No. 262, December, 1950, pp 372, 373. 1 reference.

Escape Equipment on High Speed Aircraft. *The Engineer*, Vol. 190, No. 4951, December 15, 1950, pp. 599, 600, illus. Development of the ejection seat by Martin-Baker Aircraft Co., Ltd.

CONTROL SYSTEMS

The All-Movable Horizontal Tail. Harry N. Perl. *Soaring*, Vol. 14, No. 5–6, May–June, 1950, pp. 12, 13, illus. 4 references.

Development of the all-movable horizontal tail; improvements suggested by test results; its advantages for light aircraft. This type of control surface is at present used on the Thorp Sky Skooter airplane and the Nelson Hummingbird powered sailplane.

Wings in the Air. *Aero Digest*, Vol. 61, No. 6, December, 1950, pp. 42, 90, 91, illus. The power-operated irreversible control system on the North American F-86.

LANDING GEAR

British Messier Undercarriage Development. *The Aeroplane*, Vol. 79, No. 2056, December 15, 1950, pp. 550, 551, illus. Photographs of production activities in the Messier shops at the Rotol, Ltd., factories.

WING GROUP

The Design Approximation of Skin Thickness from Stiffness Criteria. A. H. Hall. *Royal Aeronautical Society, Journal*, Vol. 54, No. 480, December, 1950, pp. 741–752, illus. 2 references.

A general approach to the problem of estimating wing thickness from preliminary design data is indicated in a manner that allows for easy calculation. Only symmetric sections are considered although the procedure can be extended to cover cambered sections.

Airports (39)

Simulation As a Means for Analyzing Airport Capacities and Methods of Airport Surface Control. S. M. Berkowitz. *Franklin Institute, Laboratories for Research and Development, Final Report No. F-2164-4*, August 15, 1950. 59 pp., illus., fold charts. 14 references.

Two simulation methods of quantitatively determining relationships between the variables in airport traffic control are described. One simulator uses prepared film transparencies with distance-time programs and handles possible ground problems in terms of time and distance. The other simulator is a slide rule capable of handling the time projection of the distance-time program. The physical concept of what is going on in each time block is not apparant when the slide rule is used. Both methods are applied to a hypothetical ground control problem at LaGuardia Airport.

The Air Carrier's View of Airport Facilities. Chas. E. Haneline. *Airports & Air Transportation*, Vol. 5, No. 85, November, 1950, pp. 124–125, 128, illus. Factors that influence airport service facilities; present flight handling procedures and suggested improvements.

The Way Out of Approach Light Gloom? F. Lee Moore. *Aviation Week*, Vol. 53, No. 24, December 11, 1950, pp. 46, 47, 49–52, illus. Details of the Centerline lighting approach system.

Aviation Medicine (19)

Visual Deficiency and Flying Experiment Following Flight Training. David Bakan and E. S. Ewart. *U.S., Civil Aeronautics Administration, Division of Research, Report No. 94*, November, 1950. 41 pp. 3 references.

A study on the relationship between visual ability and flight performance to give information on (1) the amount of flying done by visual normals and by visual defectives after completion of flight training and (2) the experience of both groups with accidents and hazardous situations. The results of questionnaires sent to pilots are analyzed.

Psychological Studies of Advanced Naval Air Training: Analysis of Flight Performance Ratings (Psychological Evaluation of Training Devices). W. R. Mahler and G. K. Bennett. (The Psychological Corporation.) *U.S., Office of Naval Research, Special Devices Center, Technical Report No. SDC 999-1-2*, September 1, 1950. 43 pp., illus. 8 references.

Psychological Studies of Advanced Naval Air Training: Evaluation of Operational Flight Trainers (Psychological Evaluation of Training Devices). W. R. Mahler and G. K. Bennett. (The Psychological Corporation.) *U.S., Office of Naval Research, Special Devices Center, Technical Report No. SDC 999-1-1*, September 1, 1950. 150 pp., illus. 15 references.

The Manual-Verbal Response Tachistoscope: Distracting Device for Intelligibility Testing (Psychological Studies of Training Techniques). D. K. Wilson. (Purdue University.) *U.S., Office of Naval Research, Special Devices Center, Technical Report No. SDC 104-2-20*, June 1, 1950. 17 pp.

Hypoxia Warning Device. *Military Surgeon*, Vol. 107, No. 6, December, 1950, pp. 474, 475, illus.

Dramamine for Prevention of Airsickness in Airborne Troops. I. Jacques Yetwin. *Military Surgeon*, Vol. 197, No. 6, December, 1950, pp. 453–455. 5 references.

Escape Equipment on High Speed Aircraft. *The Engineer*, Vol. 190, No. 4951, December 15, 1950, pp. 599, 600, illus. Development of the ejection seat by Martin-Baker Aircraft Co., Ltd.

Permeability of Glass Wool and Other Highly Porous Media. Arthur S. Iberall. *U.S., National Bureau of Standards, Journal of Research*, Vol. 45, No. 5, November, 1950, pp. 398–406, illus. 8 references. (Also available as *Research Paper No. 2150*. U.S. Govt. Printing Office, Washington. $0.10.)

Theoretical investigation of the permeability of highly porous media that consist of randomly arrayed filaments. Theory relating the permeability to the structure is reviewed. Currently accepted theory, applicable to materials of low porosity, and the theory developed in this paper for highly porous materials are extended to give approximate correlations for materials of intermediate porosity. For fibrous materials of high porosity, permeability varies with flow with absolute gas pressure at high and low Reynolds Numbers. Suitable data are given for the design of linear flowmeters that use highly porous fibrous materials. The work was done in the Bureau of Aeronautics, Navy Dept., in the development of a suitable flowmeter for diluter-demand oxygen regulators.

Education & Training (38)

Visual Deficiency and Flying Experiment Following Flight Training. David Bakan and E. S. Ewart. *U.S., Civil Aeronautics Administration, Division of Research, Report No. 94*, November, 1950. 41 pp. 3 references.

A study on the relationship between visual ability and flight performance to give information on (1) the amount of flying done by visual normals and by visual defectives after completion of flight training and (2) the experience of both groups with acci-

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dents and hazardous situations. The results of questionnaires sent to pilots are analyzed.

High Latitude Navigation Trainer. *Aviation Week*, Vol. 53, No. 26, December 25, 1950, pp. 31, illus. The Link D-2 High-Speed High-Latitude Celestial Navigation Trainer.

Ground Trainer for New Airways. *Aero Digest*, Vol. 61, No. 6, December, 1950, pp. 44, 86, illus. An all-weather radio aids unit, developed by Link Aviation, Inc., simulates electronically all the VOR, DME, and ILS facilities.

Electronics (3)

Telemetered Vibration Data. *Machine Design*, Vol. 22, No. 12, December, 1950, pp. 119, 120, illus.

A system for recording and analyzing telemetered vibration data converts vibration into an electrical signal. Output from a velocity-type pickup is fed into a telemetering transmitter operating at 85 megacycles. The frequency-modulated telemetered signal is received by a modified Navy-type RBF-3 receiver, recording the vibration data in a block diagram.

Magnetic Tape Recorder for Very Low Frequency Phenomena. Paul E. Green, Jr. *Review of Scientific Instruments*, Vol. 21, No. 11, November, 1950, pp. 893–895, illus. 2 references. Description of an apparatus for recording electrical signals of frequencies <100 cycles per sec. on magnetic tape for playback.

Structural Measurements on Complex Aircraft Components Using Strain-Gage Summation Circuits. Maurice A. Walter. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 101–106, illus. 5 references.

Electric strain gages are used for the simple measurement of net loads on an airfoil surface of complex structure without previous knowledge of the load distribution. A summation electric strain-gage circuit measured the net incremental load through a single electric output signal. Air load is obtained by correlating the net load with inertia effects. Properly located strain-gage circuits were electrically combined into a simple bridge circuit to make the signal output independent of load distribution, enabling shear and bending moments to be determined.

The CAA VHF Omnirange. H. C. Hurley, S. R. Anderson, and H. F. Keary. *U.S., Civil Aeronautics Administration, Technical Development Report No. 113*, June, 1950. 65 pp., illus. 15 references.

The development and operation of a VHF omnirange system operating in the 112–118 megacycle band. The system produces two signals, each of 30 cycles per sec.; one signal is independent of the aircraft's position and is constant in phase, and the other signal varies in relative phase directly with the magnetic bearing of the aircraft from the station. The system has an accuracy of $\pm 1.5°$.

Radio for the Executive Aircraft. George H. Handwork. *Aviation Age*, Vol. 14, No. 6, December, 1950, pp. 26, 27, illus. Proper selection and use.

UHF Distance Measuring Equipment for Air Navigation. R. C. Borden, C. C. Trout, and E. C. Williams. *U.S., Civil Aeronautics Administration, Technical Development Report No. 114*, June, 1950. 42 pp., illus. 9 references. Review of the basic principles; description of the equipment.

The Phase Comparison Localizer. S. E. Taggart and V. E. Willey. *U.S., Civil Aeronautics Administration, Technical Development Report No. 115*, June, 1950. 10 pp., illus., block diagrs. 2 references.

Development history. The difference in phase between two voltages of the same frequency is measured. The system operates on principles similar to the omnirange and uses the same transmitting equipment.

Checking Localizer Beam Widths. Cecil C. Pine. *Aviation Age*, Vol. 14, No. 6, December, 1950, pp. 28, 29, illus. A process for checking I.L.S. localizer beam widths.

Ferranti Ltd. Distance Measuring Equipment. *Shell Aviation News*, No. 149, November, 1950, p. 21, illus.

PAA Radio Telephone Girdles the Globe. George L. Christian. *Aviation Week*, Vol. 53, No. 24, December 11, 1950, pp. 37, 38, illus.

Periodical Literature for Electronic Engineers. R. C. Coile. *Institute of Radio Engineers, Proceedings*, Vol. 38, No. 12, December, 1950, pp. 1380–1384, illus. 6 references.

Discussion on "Shoran—An Electronic Tool for Surveying and Mapping" by J. L. Rannie. B. G. Ballard. *Engineering Journal*, Vol. 33, No. 11, November, 1950, pp. 982–984, illus.

Pulse Code Modulation. Liscum Diven and Sidney Moskowitz. *Radio & Television News*, Vol. 45, No. 1 (*Radio-Electronic Engineering*, Vol. 16, No. 1), January, 1951, pp. 12A–14A, 30A, 31A, illus. 10 references.

Problems of Submerged Antennas. *Aviation Week*, Vol. 54, No. 1, January 1, 1951, pp. 26, 27, illus.

Problems encountered in the development of submerged aircraft antennas; how Marconi Wireless Telegraph Co. Ltd. solved the design problem successfully for the de Havilland Comet.

Theory of Collinear Antennas. Ronold King. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1232–1251, illus. 6 references.

Stabilized Power Pack; Running Two Stabilizing Valves in Parallel to Provide High Current Output. R. E. Harvison. *Electronic Engineering*, Vol. 22, No. 274, December, 1950, pp. 512, 513, illus.

Precision A.C. Voltage Stabilizers. IV. G. N. Patchett. *Electronic Engineering*, Vol. 22, No. 274, December, 1950, pp. 499–503, illus. 1 reference.

Design of Iron Cored Inductances Carrying D.C. N. H. Crowhurst. *Electronic Engineering*, Vol. 22, No. 274, December, 1950, pp. 516–523, illus.

Growing Piezoelectric Crystals. A. C. Walker. *Franklin Institute, Journal*, Vol. 250, No. 6, December, 1950, pp. 481–524, illus. 16 references.

Summary of work carried out at the Bell Telephone Laboratories on the growing of large single crystals of three different piezoelectric materials: ammonium dihydrogen phosphate (ADP), ethylenediamine tartrate (EDT), and quartz. Included are illustrations of some basic principles observed in the growing of these crystals, descriptions of improved apparatus for their growth, and pilot-plant problems encountered in conjunction with the commercial production of ADP and EDT.

The Calculation of Waveform Distortion in Iron-Cored Audio-Frequency Transformers. K. A. Macfadyen. (*I.E.E., Measurements Section, Paper No. 1068.*) *Institution of Electrical Engineers, Proceedings, Part II, Power Engineering*, Vol. 97, No. 60, December, 1950, pp. 809–811, illus. 3 references.

The Effect of Capacitance on the Design of Toroidal Current-Transformers. A. H. M. Arnold. (*I.E.E., Measurements Section, Paper No. 102.*) *Institution of Electrical Engineers, Proceedings, Part II, Power Engineering*, Vol. 97, No. 60, December, 1950, pp. 797–808, illus. 3 references.

Applications for Thyrite Resistors. Rufus P. Turner. *Radio & Television News*, Vol. 45, No. 1, January, 1951, pp. 50, 51, 157–159, illus. 8 references.

A Relationship Between Resistance and Temperature of Thermistors. G. Bosson, F. Gutmann, and L. M. Simmons. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1267, 1268, illus. 2 references.

A New Type of Controlled Wave Shape Generator. W. D. Williams and R. D. Robinson. *General Electric Review*, Vol. 53, No. 12, December, 1950, pp. 47–50, illus. 3 references. Electronic power supply for producing desired wave shapes of voltage, to provide data on electrical and magnetic phenomena associated with nonsinusoidal excitations.

Microwave Measurements. J. Racker. *Radio & Television News*, Vol. 45, No. 1 (*Radio-Electronic Engineering*, Vol. 16, No. 1), January, 1951, pp. 15A–18A, illus. 9 references.

Relation of Nyquist Diagram to Pole-Zero Plots in the Complex Frequency Plane. *Institute of Radio Engineers, Proceedings*, Vol. 38, No. 12, December, 1950, pp. 1454, 1455, illus.

The Physical Realization of an Electronic Digital Computer. A. D. Booth. *Electronic Engineering*, Vol. 22, No. 274, December, 1950, pp. 492–498, illus. 3 references.

Marginal Checking As an Aid to Computer Reliability. Norman H. Taylor. *Institute of Radio Engineers, Proceedings*, Vol. 38, No. 12, December, 1950, pp. 1418–1421, illus. 6 references.

Marginal checking uses performance margins to establish the life expectancy of components, so that those with low margins can be removed during the testing period. Marginal checking varies voltages in logical circuit groups, inducing inferior parts to cause failure, while a test program or pulse transmission detects and localizes potential failure. In a digital computer, this can be automatically accomplished with the computer itself acting as the detector.

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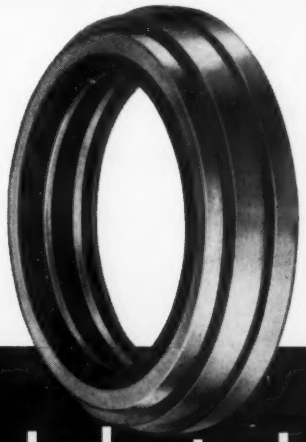

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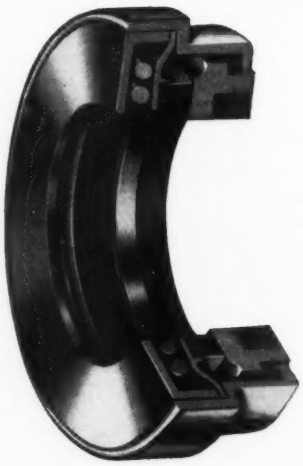

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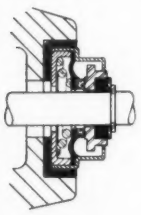

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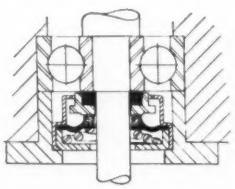

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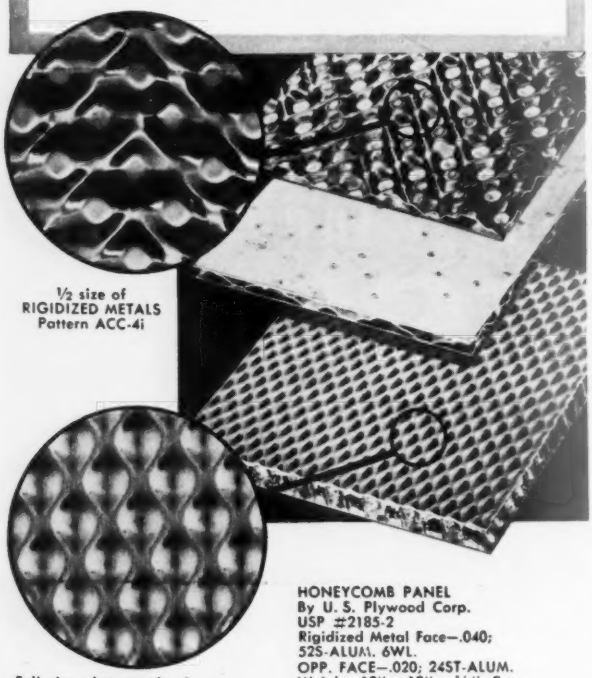

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A Digital Electronic Correlator. Henry E. Singleton. *Institute of Radio Engineers, Proceedings*, Vol. 38, No. 12, December, 1950, pp. 1422–1428, illus. 9 references.

A technique for the electronic computation of correlation functions is based on the relation between the correlation functions and the general theory of communications. General design specifications, circuit features, and construction are given of a binary digital computer that will carry out the computation.

Stratospheric-Ionospheric Relationships. N. C. Gerson. *Institute of Electrical Engineers, Proceedings*, Vol. 38, No. 12, December, 1950, p. 1456.

The Use of Atmospherics to Study the Propagation of Very Long Radio Waves. F. F. Gardner. *Philosophical Magazine*, Vol. 41 (7th Series), No. 323, December, 1950, pp. 1259–1269, illus. 4 references.

Records of the average field strength of atmospherics on frequencies of 3.5–50 kilocycles per sec. were used to investigate the manner in which propagation conditions varied with distance and with day and night.

The Effect of Magnetic Field on the Breakdown of Gases at Microwave Frequencies. Benjamin Lax, W. P. Allis, and Sanborn C. Brown. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1297–1304, illus. 9 references.

Magneto-Ionic Triple Splitting of Ionospheric Waves. O. E. H. Rydbeck. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1205–1214, illus. 14 references.

Comparison of Tropospheric Reception at 44.1 Mc with 92.1 Mc over the 167-Mile Path of Alpine, New Jersey, to Needham, Massachusetts. Greenleaf W. Pickard and Harlan T. Stetson. *Institute of Radio Engineers, Proceedings*, Vol. 38, No. 12, December, 1950, pp. 1450, illus. 1 reference.

Feedback in Magnetic Amplifiers. Alan S. Fitzgerald. *Electrical Communication*, Vol. 27, No. 4, December, 1950, pp. 298–319, illus. 5 references.

Equipment

ELECTRICAL (16)

Direct Current Control in Aircraft. J. D. Miner and B. O. Austin. *Aero Digest*, Vol. 61, No. 6, December, 1950, pp. 28, 29, 58, 60–62, illus.

A 24-volt d.c. electrical system for aircraft. Two methods of fault protection are explained: the use of current-balance relays and the use of balance of voltage drops across two shunts.

The Need for Equipment to Test Aircraft Electric Motors. I. E. Ross. *Electrical Engineering*, Vol. 70, No. 1, January, 1951, pp. 41–46, illus. 7 references.

Special test facilities are needed to evaluate aircraft electric motors. The test program and equipment of one manufacturer are described for checking rotating electric equipment that does not exceed 100 lbs. in weight, overall dimensions of 30 × 10 × 15 in., and d.c. or a.c. power dissipation of 5 kw.

HYDRAULIC & PNEUMATIC (20)

Designing for Minimum Surge. Fred O. Hosterman. *Applied Hydraulics*, Vol. 3, No. 11, December, 1950, pp. 38–40, illus.

Control of the time factor in the elimination or reduction of hydraulic-system surges by regulating the actuation speed of the control valve or changing the modulation characteristics of the valve. Design suggestions are given for reducing the surges.

Pneumatics Powers New Plane Systems. George L. Christian. *Aviation Week*, Vol. 54, No. 1, January 1, 1951, pp. 28, 29, illus. Design and operation of a 4-cylinder 4-stage air compressor developed by Walter Kidde & Co., Inc.

Flight Operating Problems (31)

PILOTING TECHNIQUE

Flight on Asymmetric Engine Power. I. E. Wright. *Aircraft Engineering*, Vol. 22, No. 262, December, 1950, pp. 350–355, 374, illus. 5 references.

Flight in a multiengined aircraft when one or more engines has failed or stopped on a particular wing. The dangers involved under such flying conditions are explained; the methods of overcoming these dangers are evaluated and compared. Efficient

handling of the aircraft in conditions of asymmetric power depends directly on the skill and knowledge of the pilot in flying and landing the aircraft.

REFUELING IN FLIGHT

The Case for Flight Refuelling; Applications of the Probe and Drogue System. Alan J. Cobham. *Shell Aviation News*, No. 149, November, 1950, pp. 8–11, illus.

Operation of the probe and drogue system developed by Flight Refuelling Ltd. Increased pay load would result from the use of flight refueling in commercial and military aviation.

Flight Safety & Rescue (15)

Relation Between Inflammables and Ignition Sources in Aircraft Environments. Wilfred E. Scull. *U.S., N.A.C.A., Technical Note No. 2227*, December, 1950. 126 pp., illus. 145 references. A survey of the literature on aircraft fire hazards.

Jets Ablaze. Howard A. Klein. *Aero Digest*, Vol. 61, No. 6, December, 1950, pp. 30, 31, 68–70, illus. Fire hazards and fire preventive measures in jet aircraft.

A Survey of Accident Causes. Philip Robins. *The Aeroplane*, Vol. 79, No. 2054, December 1, 1950, pp. 491–493, illus. A survey of fatal accidents of twin- and multiengined civil transport aircraft and their causes.

Escape Equipment on High Speed Aircraft. *The Engineer*, Vol. 190, No. 4951, December 15, 1950, pp. 599, 600, illus. Development of the ejection seat by Martin-Baker Aircraft Co., Ltd.

A Backward-Facing Seat Investigation; A Report on Studies by the Air Transport Command, Traffic Division, U.S.A.F. *Aircraft Engineering*, Vol. 22, No. 262, December, 1950, pp. 372, 373. 1 reference.

Flight Testing (13)

Structural Measurements on Complex Aircraft Components Using Strain-Gage Summation Circuits. Maurice A. Walter. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 101–106, illus. 5 references.

Electric strain gages are used for the simple measurement of net loads on an airfoil surface of complex structure without previous knowledge of the load distribution. A summation electric strain-gage circuit measured the net incremental load through a single electric output signal. Air load is obtained by correlating the net load with inertia effects. Properly located strain-gage circuits were electrically combined into a simple bridge circuit to make the signal output independent of load distribution, enabling shear and bending moments to be determined.

Camera Frames Low-Level Flight Data. *Aviation Week*, Vol. 54, No. 1, January 1, 1951, p. 25, illus.

A camera developed by Douglas Aircraft Co. which has a semicircular glass grid located between the camera lens and film. Horizontal lines on the grid represent 2°; the vertical included angle is 10°; the horizontal angle is 160°, which is the limit of the camera tracking range. This "Photoscope" camera acts as a photographic transit; it is placed on a line perpendicular to the flight path. Accurate leveling is done by a transit-type tripod.

Testing a High Lift Wing. Derek Dempster. *The Aeroplane*, Vol. 79, No. 2053, pp. 465–467, illus., cutaway drawing. Flight testing of the Youngman-Bayner high-lift research aircraft.

Fuels & Lubricants (12)

Performance Calculations of Some Fuels for Rocket Motors. Giorgio Nebbia. *British Interplanetary Society, Journal*, Vol. 9, No. 6, November, 1950, pp. 286–289, illus. 7 references.

The theoretical performance of some mixtures of nongasoline fuels and liquid oxygen are calculated according to the method developed by Hottel and his coworkers. The performance of 75 per cent ethyl alcohol, 100 per cent ethyl alcohol, diethyl ether, propane, butane, and gasoline are compared on an approximately "equal-cost" basis to determine the most economic operation of rocket and ram-jet motors.

Fundamental Flame Velocities of Pure Hydrocarbons. I—Alkanes, Alkenes, Alkynes, Benzene, and Cyclohexane. Melvin Gerstein, Oscar Levine, and Edgar L. Wong. *U.S., N.A.C.A., Research Memorandum No. E50G24*, September 28, 1950. 26 pp., illus. 3 references.

Synthesis and Purification of Alkydiphenylmethane Hydrocarbons. I—2-Methyldiphenylmethane, 3-Methyldiphenylmethane, 2-Ethyldiphenylmethane, 4-Ethyldiphenylmethane, and 4-Isopropyldiphenylmethane. John H. Lamneck, Jr., and Paul H. Wise. *U.S., N.A.C.A., Technical Note No. 2230*, December, 1950. 17 pp., illus. 18 references.

Observation of the Lubricating Oil Film Between Piston Ring and Cylinder of a Running Engine; The Effects of Ring Geometry. R. L. Brooks and M. L. Atkin. *Australia, Department of Supply and Development, Aeronautical Research Laboratories, Report No. E.66*, May, 1950. 21 pp., illus. 5 references.

A qualitative method of studying the oil film involved measuring the electrical contact resistance between the top piston ring and cylinder wall of a running engine. A cathode-ray oscillograph measured the potential drop between the ring, which was insulated from the rest of the piston, and the cylinder wall when a small fixed potential was applied through a known series resistor. A single-cylinder P. & W. Wasp H air-cooled engine was used. Torsion and taper-faced rings, rings with chamfered edges, and the effect of ring bearing area were studied.

Gas Evolution in Liquids and Cavitation. P. H. Schweitzer and V. G. Szebehely. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1218–1224, illus. 3 references.

An investigation of cavitation phenomena by testing the air solubility and the rate of solution and evolution of air (when the liquid is disturbed from its equilibrium condition) of nine heavy lubricating oils, four light lubricating oils, three aircraft-engine fuels, one diesel fuel, and distilled water. The theory of the cavitation process and of the relation between cavitation and gas evolution are reviewed. Formulas are derived for the rate of evolution of the gas; an expression is obtained for the half-life of evolution (the time required for the evolution of one-half of the total evolved gas).

Improved Miniature Penetrometer Cones for Determination of Lubricating Grease Consistency. B. W. Hotten and G. M. Kibler. *Analytical Chemistry*, Vol. 22, No. 12, December, 1950, pp. 1574, 1575, illus. 4 references.

Determination of Small Amounts of Silver in Lubrication Oils by Amperometric and Gravimetric Methods. Thomas D. Parks and Louis Lykken. *Analytical Chemistry*, Vol. 22, No. 12, December, 1950, pp. 1505–1507, illus. 4 references.

Determination of Copper and Iron in Oils by Amperometric Titration. Thomas D. Parks and Louis Lykken. *Analytical Chemistry*, Vol. 22, No. 12, December, 1950, pp. 1503–1505. 9 references.

Compressor Lubrication. K. L. Hollister. *American Society for Testing Materials, Bulletin*, No. 170, December, 1950, pp. 35–37. Evaluation of five commercial oils (lubricants), each with a viscosity of approximately 300 Saybolt Universal seconds at 100°F.

Summarized Proceedings of a Conference on the Physics of Lubrication, Manchester, 1950. *British Journal of Applied Physics*, Vol. 1, No. 11, November, 1950, pp. 275–285. 36 references.

Predicting Phase Behavior with Digital Computers. T. J. Connolly, S. P. Frankel, and B. H. Sage. *Electrical Engineering*, Vol. 70, No. 1, January, 1951, p. 47. 7 references. (Digest of a paper.)

Gliders (35)

Split-Block Construction; Multiple Method of Manufacturing Wood Details. J. C. Reussner. *Aircraft Production*, Vol. 12, No. 146, December, 1950, pp. 341, 342, illus.

The process consists essentially of making each part in the form of a wood block and using slices of these blocks to build the finished details. It is suitable for thin components since the depth of the parts as limited by the size that can be cut on a saw (about 12 in.). Synthetic-resin glues are used to assemble the finished parts. The process was developed by Slingsby Sailplanes, Ltd. and is used by them in the manufacture of gliders.

Development of the Nelson Hummingbird Powered Sailplane. Ted Nelson. *Soaring*, Vol. 14, No. 5–6, May-June, 1950, pp. 3, 4, 8, illus.

Catching Thermals. Emil Kissel. *Soaring*, Vol. 14, No. 5-6, May-June, 1950, pp. 10, 11, 15, illus.

Illustrated are an 8½" bellows used in jet aircraft engines and a ½" bellows suitable for instruments.

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How to Choose Winch Wire. Max Breitenbach and Marjorie Breitenbach. *Soaring*, Vol. 14, No. 5-6, May-June, 1950, p. 14. Tables and calculation procedure for determining the proper wire for a specific winch.

Guided Missiles (1)

Remarks on Low-Aspect-Ratio Configurations in Supersonic Flow. P. A. Lagerstrom and M. E. Graham. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 91–96, illus. 10 references.

Simple low-aspect-ratio configurations are examined to obtain a qualitative understanding of wing-fuselage interference and afterbody effect of a missile; nonlinear and viscous effects are neglected.

Calculation of Thermal Stresses in a Wedge-Shaped Wing. George H. Eisenhardt and Warren M. Rohsenow. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 115–123, illus. 2 references.

Derivation of procedure for computing the thermal stresses of a solid symmetric double-wedge steel wing at an altitude of 50,000 ft., at a Mach Number of 1.4, and with a temperature distribution of 531.6°F. absolute. The wedge is subjected to uniform acceleration at a rate of one Mach Number per 30 sec. at M = 1.4–6.0. Thermal stresses are calculated on the wing at M = 6.0 and on the wing root, which is solidly built into the fuselage.

Project Typhoon Aids Missile Designers; New Electronic Computer Can Solve Problems of Entire Defense System. David A. Anderton. *Aviation Week*, Vol. 53, No. 25, December 18, 1950, pp. 40, 42, illus.

Typhoon is an electronic computer that can compute the motions of any projectile through any medium. The computer was developed by a joint program of the Special Devices Center of the Office of Naval Research and Radio Corporation of America.

Wind-Tunnel Tests for Temperature Recovery Factors at Supersonic Velocities. W. F. Hilton. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 97–100, illus. 4 references.

A study of the temperature attained by an unheated body moving at supersonic speeds. The rise in temperature is due to skin friction and adiabatic compression. Temperatures were measured on the surface of a tangential ogive attached to a cylinder of 4-in. diameter at Mach Numbers of 1.73 and 2.00. The model was made of Lucite.

Readers' Forum: On Supersonic Wing-Body Center of Pressure. G. K. Morikawa and T. F. Coleman. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, p. 140, illus. 2 references.

Readers' Forum: Base Pressures at Supersonic Speeds. J. Leith Potter. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 141, 142, illus. 4 references.

Photographic Determination of the Orientation of a Rocket. L. W. Fraser and R. S. Ostrander. *Photographic Engineering*, Vol. 1, No. 4, October, 1950, pp. 105–118, illus. 2 references.

Development of the method. The position of the camera in space can be determined from a photograph that contains two or more identifiable landmarks. The orientation of the rocket is derived by means of a model that contains the fixed angular relationship of the camera to the rocket in which it is mounted.

The Peenemuende Rocket Center. IV. Krafft A. Ehricke. *Rocketscience*, Vol. 4, No. 4, December, 1950, pp. 81–88, illus. Rocket research and production during 1944–1945; the development of the JATO unit.

Instruments (9)

Wind-Tunnel Investigation of a Number of Total-Pressure Tubes at High Angles of Attack: Subsonic Speeds. William Gracey, William Letko, and Walter R. Russell. *U.S., N.A.C.A., Research Memorandum No. L50G19*, September 26, 1950. 69 pp., illus. 3 references.

The variation of total-pressure error with angle of attack of 39 total-pressure tubes was determined for an angle of attack range of ±45° and an indicated air speed of 195 m.p.h. The effects of internal shape and configuration of the total pressure entry were analyzed to determine their effect on the characteristics of a tube of a given external shape.

Phase Sensitive Strain Gauge System. Alvin B. Kaufman. *Radio & Television News*, Vol. 45, No. 1 (*Radio-Electronic Engineering*, Vol. 16, No. 1), January, 1951, pp. 3A–6A, 27A, illus., circuit diagrs. 5 references. Principles of operation and components of a phase sensitive, capacitively balanced a.c. bridge for strain-gage measurements.

Structural Measurements on Complex Aircraft Components Using Strain-Gage Summation Circuits. Maurice A. Walter. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 101–106, illus. 5 references.

Electric strain gages are used for the simple measurement of net loads on an airfoil surface of complex structure without previous knowledge of the load distribution. A summation electric strain-gage circuit measured the net incremental load through a single electric output signal. Air load is obtained by correlating the net load with inertia effects. Properly located strain-gage circuits were electrically combined into a simple bridge circuit to make the signal output independent of load distribution, enabling shear and bending moments to be determined.

The Improved Ramberg Vacuum-Tube Accelerometer. *U.S., National Bureau of Standards, Technical News Bulletin*, Vol. 34, No. 12, December, 1950, pp. 180–182, illus. 3 references.

The accelerometer permits the measurement of accelerations to 5g at frequencies to 20 cycles per sec. The instrument has been improved to reduce changes in the balance point; stops have been added to limit the plate movement and thus prevent overloading.

Some Design Considerations in Connection with the Use of High Speed Thermometry for Telemetering. Vernon C. Westcott. *Instruments*, Vol. 23, No. 12, December, 1950, pp. 1298, 1299, illus.

Some Extensions in the Use of Resistance Thermometry in the Study of Gaseous Explosions. A. S. Leah, C. Rounthwaite, and D. Bradley. *Philosophical Magazine*, Vol. 41 (7th Series), No. 323, December, 1950, pp. 1289–1291, illus.

A Platinum Resistance Thermometer for Temperatures up to 750°C. A. Barthel. (*Verein deutscher Ingenieure, Zeitschrift*, Vol. 92, No. 25, September 1, 1950, pp. 726–728.) *The Engineer's Digest*, Vol. 11, No. 11, November, 1950, pp. 386, 387, illus.

Addendum to Report I.18 on the Complex-Frequency Method of Stability Analysis. B. E. Swire. *Australia, Department of Supply, Aeronautical Research Laboratories, Report No. I.18 Addendum*, July, 1950. 9 pp., illus.

Corrections to the original report. A better design is suggested for the automatic-control instrument for pilotless aircraft which was originally reported.

Investigation with an Interferometer of the Turbulent Mixing of a Free Supersonic Jet. Paul B. Gooderum, George P. Wood, and Maurice J. Brevoort. *U.S., N.A.C.A., Report No. 963*, 1950. 16 pp., illus. 10 references. U.S. Govt. Printing Office, Washington. $0.20.

Carrier Compensation for Servomechanisms. II. H. Elmore Blanton. *Franklin Institute, Journal*, Vol. 250, No. 6, December, 1950, pp. 525–542, illus. 31 references. R-C networks; other methods of carrier compensation; comparison of methods of carrier compensation.

CAA to Evaluate Three Pictorial Computer Designs. William D. Perreault. *American Aviation*, Vol. 14, No. 21, December 11, 1950, pp. 30, 31, 33, 36, illus.

The pictorial computer shows aircraft position in relation to a desired course and aircraft position along that course; information is obtained from omnirange stations and D.M.E. C.A.A. will evaluate the three different types of computers which were developed by Aero Electronics Co., Arma Corp., and Sperry Gyroscope Co. Each type is described.

The L-2 Autopilot (Lear). Leighton Collins. *Air Facts*, Vol. 13, No. 12, December, 1950, pp. 6–12, illus.

Pocket Size Pilot. John Robbins. *Aero Digest*, Vol. 61, No. 6, December, 1950, pp. 32, 71, illus. Operation of the Lear L-2 Autopilot.

Ferranti Ltd. Distance Measuring Equipment. *Shell Aviation News*, No. 149, November, 1950, p. 21, illus.

Super Thermostat. *Aero Digest*, Vol. 61, No. 6, December, 1950, p. 34, illus. A thermostat manufactured by the Vapor Heating Corp., Chicago, has a sensitivity to 0.3°F. temperature change.

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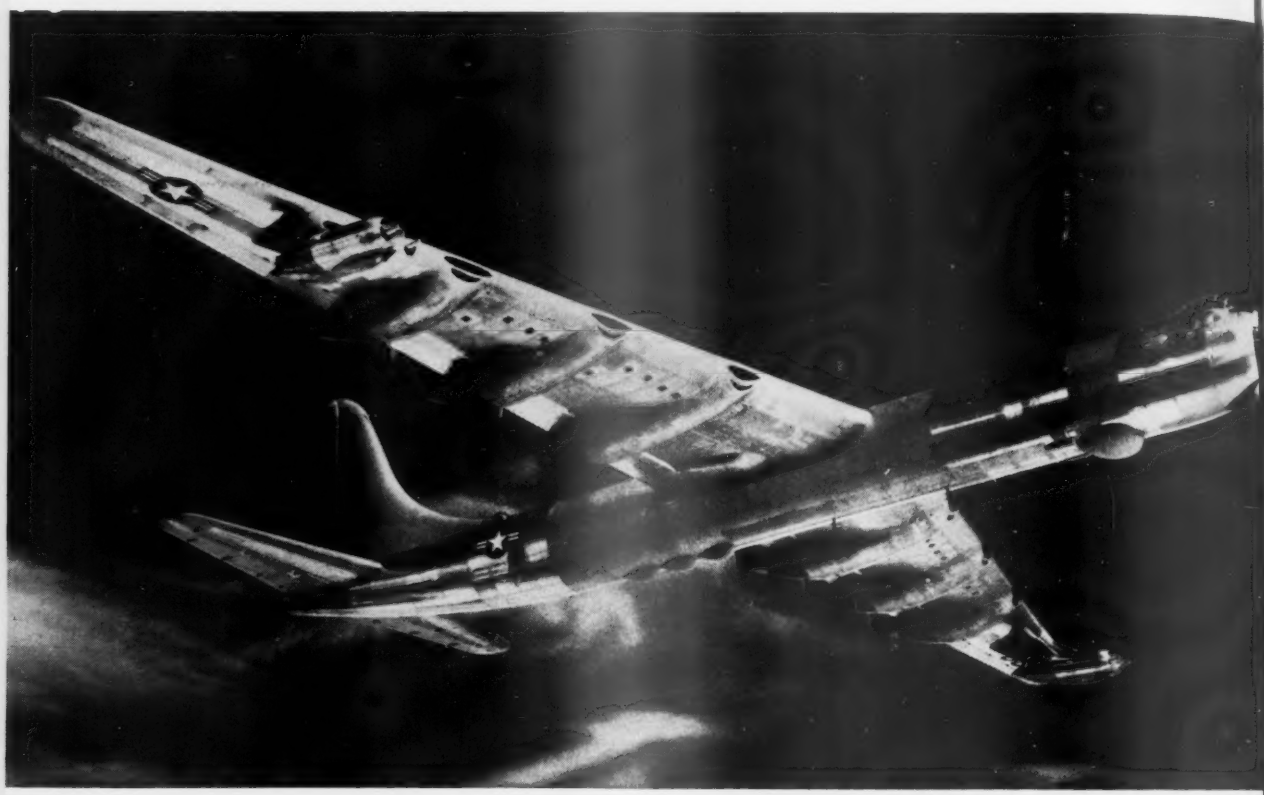

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Notes on the Care and Use of Electrical Instruments. Frank D. Weaver. *Instruments*, Vol. 23, No. 12, December, 1950, pp. 1236–1239. 5 references.

General precautions that should be observed in using electrical instruments; sources of error in the instruments and in apparatus used with the instruments; proper measurement procedures.

Deformations and Stresses in Bourdon Tubes. R. A. Clark and E. Reissner. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1340, 1341, illus. 6 references.

Some Instruments in the Oil Laboratory. R. J. S. Pigott. *Instruments*, Vol. 23, No. 12, December, 1950, pp. 1240–1243, 1288, 1290, illus.

Laws & Regulations (44)

The Legal Status of Executive Agreements on Air Transportation. I. Oliver J. Lissitzyn. *Journal of Air Law & Commerce*, Vol. 17, No. 4, Autumn, 1950, pp. 436–453.

Report to the Association of the Bar of the City of New York of Subcommittee on the Warsaw Convention Adopted and Approved by the Committee on Aeronautics, May 9, 1950. *Journal of Air Law & Commerce*, Vol. 17, No. 4, Autumn, 1950, pp. 474–478. A discussion of the adherence of the U.S. to the rulings of the Warsaw Convention on the limits of the liability for the death or personal injury of a passenger.

The Meaning of "Incidental to Transportation by Aircraft" As Used in Section 203 (b) (7a) of the Interstate Commerce Act. Russell S. Bernhard. *Journal of Air Law & Commerce*, Vol. 17, No. 4, Autumn, 1950, pp. 400–417. 20 references.

1950 Report of American Bar Association Standing Committee on Aeronautical Law. *Journal of Air Law & Commerce*, Vol. 17, No. 4, Autumn, 1950, pp. 468–474. 6 references.

NASAO Activities. Madeline C. Dinu. *Journal of Air Law & Commerce*, Vol. 17, No. 4, Autumn, 1950, pp. 479–486. Reports on activities in civilian defense mobilization plans.

The Aviation Hazard in Radio-Television Progress. Howard Joseph. *Journal of Air Law & Commerce*, Vol. 17, No. 4, Autumn, 1950, pp. 487–490. 15 references.

Machine Elements (14)

Further Principles of Buffer Design. Joseph Brown. *Product Engineering*, Vol. 21, No. 12, December, 1950, pp. 125–129, illus.

Formulas for the design of hydraulic buffers. Equations are given for the following: constant-orifice buffer, constant-deceleration buffer, approximately constant-deceleration buffer, and various orifice types. The analyses are applicable to devices concerned with hydraulic metering problems, controlled variable accelerations, and energy dissipation.

Why Machine Parts Fail. VIII—When Not to Blame the Designer. Charles Lipson. *Machine Design*, Vol. 22, No. 12, December, 1950, pp. 151–156, illus. 10 references.

BEARINGS

Stepped Film Bearings. Frank R. Archibald. *Machine Design*, Vol. 22, No. 12, December, 1950, pp. 171, 172, illus. 2 references.

FASTENINGS

Types of Mounts for Vibration Isolation. Thomas R. Finn. *Product Engineering*, Vol. 21, No. 12, December, 1950, pp. 130, 131, illus. Illustrations of strip-type isolators and individual mounts.

Natural Frequency and Efficiency of Vibration Mounts. Charles E. Crede. *Product Engineering*, Vol. 21, No. 12, December, 1950, p. 167, illus. A chart for obtaining the effectiveness of a vibration mount.

Designing for Shock Resistance. I. Charles E. Crede and Miguel C. Junger. *Machine Design*, Vol. 22, No. 12, December, 1950, pp. 161–167, illus. Analysis of principles relating to shock resistance of structures.

GEARS & CAMS

A New Infinitely Variable Gear. *The Aeroplane*, Vol. 79, No. 2055, December 8, 1950, pp. 517, 518, illus.

The Gerritsen gear, developed by Tiltman Langley Laboratories, Ltd., provides an infinitely variable unit with ratios in the 1:1 range or with high reductions and can operate at high speeds. This unit is of the mechanical friction type, and it consists of some hard steel balls running without slip over four coned hard steel surfaces; the balls are preloaded between the surfaces. The rolling characteristics of the balls are determined by fixing the positions of two of the surfaces relative to each other; the gear ratio is varied by changing the position of the surfaces. The gear is self-governing.

Discussion: Stresses and Deflections of Cylindrical Bodies in Contact, with Application to Contact of Gears and of Locomotive Wheels, by J. Poritsky. E. E. Bisson, B. S. Cain, Alexander Hammer, H. G. Hopkins, and F. K. G. Odqvist. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 465–468, illus. 8 references.

A Problem in Precision Cam Design. Joseph Blum. *U.S., National Bureau of Standards, Journal of Research*, Vol. 45, No. 6, December, 1950, pp. 502–504, illus. 2 references. (Also available as *Research Paper No. 2164.* U.S. Govt. Printing Office, Washington. $0.10.)

Development of an analytic method for determining the profile of a cam required in a high-precision device. The profile is determined numerically as the envelope of a family of curves resulting from the assumption that the follower makes contact at a fixed point on the edge.

KINEMATICS OF MACHINERY

Discussion: Acceleration of the Instant Center, by W. J. Carter. A. S. Hall, P. G. Jones, and L. R. Koenig. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 468–470, illus. 2 references.

MECHANISMS & LINKAGES

Systematic Design of Mechanisms. H. Ziebolz. *Machine Design*, Vol. 22, No. 12, December, 1950, pp. 126–136, illus. 9 references.

A systematic design approach in which each component of the mechanism is represented by either a letter or a block symbol, thus cataloging the mechanism in terms of operation or function. A schematic diagram can then be used to represent the mechanism.

SHAFTS & ROTATING DISCS

Torsion of a Circular Shaft with a Number of Longitudinal Notches. H. Ōkubo. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 359–362, illus. 4 references.

Solution of a shaft with notches by using elementary functions, the solution is obtained with less numerical work than when it is obtained by the methods of Weber and Shepherd. The solution is first obtained for a circular shaft with one semicircular notch and is extended to a circular shaft with shallow notches of any form. The method is valid for a shaft with shallow notches but often fails for the shaft with deep notches.

Critical Speeds of Overhung Shafts. H. C. Hesse. *Product Engineering*, Vol. 21, No. 12, December, 1950, pp. 90–93, illus. Calculation procedure for the design of overhung shafts with one or more loads concentrated at a point or points away from the outboard support.

SPRINGS

Nomographic Design of Helical Springs. John H. Keyes. *Machine Design*, Vol. 22, No. 12, December, 1950, pp. 173, 174.

TRANSMISSIONS, CLUTCHES, & DRIVES

Further Development of the NBS Magnetic Fluid Clutch. *U.S., National Bureau of Standards, Technical News Bulletin*, Vol. 34, No. 12, December, 1950, pp. 169–174, illus. 10 references.

Maintenance (25)

Turbojet Engines—Service Experience. John W. Bailey. *SAE Journal*, Vol. 51, No. 12, December, 1950, pp. 23–25, illus. (Excerpts from a paper.) Allison J35 and J33.

The Functioning of a Manufacturer's Service Department. A. J. Brant. *The Technical Instructor*, Vol. 5, No. 11, November, 1950, pp. 3–12, illus. de Havilland Aircraft Co., Ltd.

Servicing the Jetliner (Avro). *The Technical Instructor*, Vol. 5, No. 11, November, 1950, pp. 13–15, 17, illus.

BEAC's Maintenance Incentive System. Denis Desoutter. *Aviation Age*, Vol. 14, No. 6, December, 1950, p. 19, illus. A bonus incentive system used by British European Airways in its maintenance work.

Cleaning Oil Coolers Difficult Problem. II. G. L. Derham. *Canadian Aviation*, Vol. 23, No. 12, December, 1950, pp. 37, 38, illus.

Boeing Service Guide. Nos. 38, 39, November, December, 1950. 8, 8 pp., illus. Model 377 Stratocruiser.

Materials (8)

A Warning to Designers. P. L. Teed. *The Aeroplane*, Vol. 79, No. 2053, November 24, 1950, pp. 451–454, illus. (Extended summary of a paper.) Engineering problems arising from the behavior of metals at the low temperatures of the stratosphere.

On the Theory of Dislocations. John Lee Bogdanoff. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1258–1262. 6 references.

METALS & ALLOYS

Effects of Prior Static and Dynamic Stresses on the Fatigue Strength of Aluminum Alloys. John A. Bennett and James L. Baker. *U.S., National Bureau of Standards, Journal of Research*, Vol. 45, No. 6, December, 1950, pp. 449–457, illus. 9 references. (Also available as *Research Paper No. 2157*. U.S. Govt. Printing Office, Washington. $0.10.)

Evaluation by fatigue tests at two stress levels of some of the factors involved when a sample of Alclad 24S-T is damaged by repeated stresses until a small crack is formed. Prior static loading has a definite effect on the fatigue strength in unidirectional bending when the amplitude of the applied stress is relatively small.

Comparison of Fatigue Strengths of Bare and Alclad 24S-T3 Aluminum-Alloy Sheet Specimens Tested at 12 and 1,000 Cycles per Minute. Frank C. Smith, William C. Brueggeman, and Richard H. Harwell. *U.S., N.A.C.A., Technical Note No. 2231*, December, 1950. 18 pp., illus. 7 references.

Plastic Biaxial Stress-Strain Relations for Alcoa 24S-T Subjected to Variable-Stress Ratios. Joseph Marin and B. J. Kotalik. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 372–376, illus. 1 reference.

Experimental investigation of biaxial plastic stress-strain with variable stress ratios subjecting tubular specimens to axial tension and internal pressure. Relations are given for the stress-strain with both constant and variable stress ratios, and experimental results are compared with theory.

Consideration on the Relationship Between Stress and Strain in Plastic Metals. J. H. Palm. *Metalen*, Vol. 5, No. 1, September, 1950, pp. 9–14, illus. 7 references. In English. Reprint. Extension of the stress-strain formula for isothermal homogeneous deformation in uniaxial tension on the basis of energy considerations.

Copper-Bearing, High-Strength Wrought Aluminum Alloys. (Materials Data Sheet No. 202.) *Materials & Methods*, Vol. 32, No. 6, December, 1950, p. 83.

Plastic Flow of Platinum Wires. R. P. Carreker, Jr. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1289–1296, illus. 12 references. Experimental investigation of the strain-time behavior of annealed platinum wires at constant stress and temperature.

Some Applications of Electrochemical Thermodynamics. Marcel Pourbaix. *Corrosion*, Vol. 6, No. 12, December, 1950, pp. 395–404, illus. 16 references.

Analysis of the electrochemical reactions that can take place on the same metallic surface. The theory underlying the affinity, velocity, and direction of the reaction, and the polarization curves is reviewed. This analysis is applied to the behavior of iron in an aqueous solution, and to the reaction between hydrogen and some oxidizing substances on platinum.

NONMETALLIC MATERIALS

The Strength of Glued Metal Joints. A. Hartman. (*De Ingenieur*, Vol. 61, No. 11, *Supplement: Materialenkennis*, No. 4, March 18, 1949.) *Aero Research Ltd., Aero Research Technical Notes, Bulletin No. 95*, November, 1950. 10 pp., illus. 6 references.

Tests were made on four adhesives for bonding metals: Araldite, Metlbond, Pliobond, and Redux. The glued portions were subjected to tensile and compression tests and bending tests.

Why Consider Adhesive Bonded Structures? Seth Gunthorp and Richard G. Naugle. *Product Engineering*, Vol. 21, No. 12, December, 1950, pp. 138–143, illus. Advantages of adhesive metal-to-metal bonding; characteristics of the adhesives; strength of bonded joints; design factors involved; bonding procedures.

Factors Affecting the Crazing of Polystyrene. Bryce Maxwell and L. F. Rahm. *Society of Plastics Engineers, Journal*, Vol. 6, No. 9, November, 1950, pp. 7–12, illus. 3 references.

A study of the growth of cracks, including strain effects; the effect of orientation on the critical elongation, the reversibility of crazing, and the effect of organic solvents on the crazing of polystyrene. The results of all the experiments indicate that crazing is due to the pulling apart of the material, the process starting in the regions where the orientation of the chains is more generally in a direction normal to the direction of straining.

The Mechanical Equation of State with Special Attention to the Creep of Plastics. William N. Findley. *Society of Plastics Engineers, Journal*, Vol. 6, No. 10, December, 1950, pp. 13–16, illus. 12 references.

Industrial Applications of Thermosetting Laminated Plastic Tubing. Duane E. Roland. *Materials & Methods*, Vol. 32, No. 6, December, 1950, pp. 64–66, illus.

Laminated plastic tubing has a high strength-weight ratio. Some of its applications are: landing-gear shock struts, insulators, coil forms in transmitters and receivers, and anodizing baskets for aircraft rivets.

Permeability of Glass Wool and Other Highly Porous Media. Arthur S. Iberall. *U.S., National Bureau of Standards, Journal of Research*, Vol. 45, No. 5, November, 1950, pp. 398–406, illus. 8 references. (Also available as *Research Paper No. 2150*. U.S. Govt. Printing Office, Washington. $0.10.)

Theoretical investigation of the permeability of highly porous media that consist of randomly arrayed filaments. Theory relating the permeability to the structure is reviewed. Currently accepted theory, applicable to materials of low porosity, and the theory developed in this paper for highly porous materials are extended to give approximate correlations for materials of intermediate porosity. For fibrous materials of high porosity, permeability varies with flow with absolute gas pressure at high and low Reynolds Numbers. Suitable data are given for the design of linear flowmeters that use highly porous fibrous materials. The work was done in the Bureau of Aeronautics, Navy Dept., in the development of a suitable flowmeter for diluter-demand oxygen regulators.

PROTECTIVE COATINGS

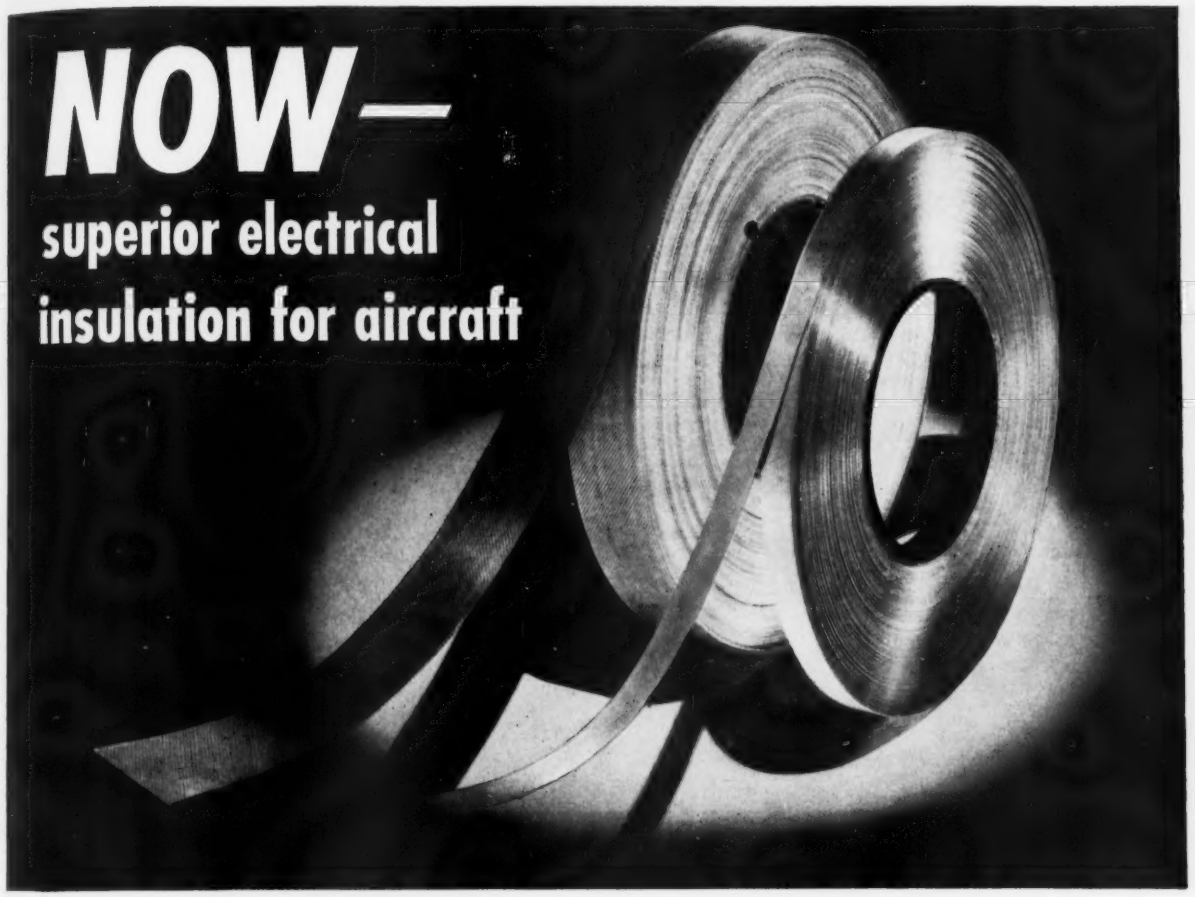
Evaluation of Rubbing Compounds for Use on Lacquered Aircraft Surfaces. Roy A. Machlowitz. *American Society for Testing Materials, Bulletin*, No. 170, December, 1950, pp. 31–35, illus. 3 references. Determination of the properties of 21 rubbing compounds as a basis for a specification covering procurement of rubbing compounds for the lacquered surfaces of naval aircraft.

SANDWICH MATERIALS

Bending and Buckling of Rectangular Sandwich Plates. N. J. Hoff. *U.S., N.A.C.A., Technical Note No. 2225*, November, 1950. 28 pp., illus. 9 references.

Differential equations and boundary conditions are derived. The buckling load is calculated for a simply supported plate subjected to edgewise compression. The formulas obtained are evaluated numerically, and the results are plotted in a diagram. The theory is in satisfactory agreement with results of tests carried out at the Forest Products Laboratory.

Effect of Cell Shape on Compressive Strength of Hexagonal Honeycomb Structures. L. A. Ringelstetter, A. W. Voss, and C. B. Norris. *U.S., N.A.C.A., Technical Note No. 2243*, December, 1950. 9 pp., illus. 2 references. Compression tests on hexagonal-honeycomb material made of untreated 50-lb. kraft paper and strips of phenolic film adhesive.



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Meteorology (30)

The Upper Atmosphere—Its Exploration and Exploitation. Willy Ley. *Aeronautical Engineering Review*, Vol. 10, No. 2, February, 1951, pp. 20–24, 30, illus.

On the Origin of Tornadoes. Morris Tepper. *American Meteorological Society, Bulletin*, Vol. 31, No. 9, November, 1950, pp. 311–314, illus. 6 references.

Dynamics of the Eye of the Storm. M. Magata. *Papers in Meteorology and Geophysics*, Vol. 1, No. 1, October, 1950, pp. 29–37, illus. 10 references.

An Improved Fully Electric Radiosonde. Karl Sittel and Ernst Menzer. *American Meteorological Society, Bulletin*, Vol. 31, No. 9, November, 1950, pp. 341–346, illus. 8 references.

This fully electric radiosonde uses the Finnish principle. The temperature is measured with a temperature sensitive dielectric; the humidity, by the determination of the psychrometric difference; and the pressure, by a corrugated diaphragm that positions a cylindrical condenser. The measuring elements and the construction of the sonde, as well as the calibration and receiving station, are outlined. The more important phases of the investigation are briefly mentioned, and a comparison of the temperature measurements with a number of other sondes is given.

Studies on Biplane Wing Vanes, Ventilator Tubes and Cup Anemometers. I. M. Sanuk. *Papers on Meteorology and Geophysics*, Vol. 1, No. 1, October, 1950, pp. 81–132, illus. 8 references. The mathematical treatment of the problems is given to provide the basis for establishing the experimental and design techniques.

Automatic Frost Point Hygrometer. Stanley H. Jury and William Light, Jr. *Analytical Chemistry*, Vol. 22, No. 12, December, 1950, pp. 1536–1540, illus 6 references.

Electronic Meteorological Instruments in the India Meteorological Department. S. P. Venkiteshwaran. *Journal of Scientific & Industrial Research*, Vol. 9A, No. 9, September, 1950, pp. 310–313, illus. 6 references.

A Meteorograph for Low Altitude Sounding. William H. Parrott, Robert G. Paquette, and Phil E. Church. *American Meteorological Society, Bulletin*, Vol. 31, No. 9, November, 1950, pp. 336–340, illus. 5 references.

Wind-Direction and Speed Robot. H. Kamamoto and S. Kimura. *Papers on Meteorology and Geophysics*, Vol. 1, No. 1, October, 1950, pp. 77–80, illus.

Design of an automatic wind direction and speed station for use on the southern islands of Japan. The equipment, which consists of a transmitter and receiving set (located at the main weather station), uses a carrier wave of 416 megacycles per sec. The effect of temperature on the performance of the robot is studied.

Observation of Precipitation with an Airborne Radar. E. J. Smith. *Australian Journal of Scientific Research, Series A, Physical Sciences*, Vol. 3, No. 2, June, 1950, pp. 214–223, illus. 6 references.

Some Preliminary Studies of the Rapid Variations in the Index of Refractions Atmospheric Air at Microwave Frequencies. C. M. Crain and J. R. Gerhardt. *American Meteorological Society, Bulletin*, Vol. 31, No. 9, November, 1950, pp. 330–335, illus. 11 references.

Correspondence: A Virtual Echo-Layer Above the Bright Band. David Atlas and Harold C. Banks. **Reply.** Pauline M. Austin and Alan C. Bemis. *Journal of Meteorology*, Vol. 7, No. 6, December, 1950, pp. 402–404, illus. 6 references.

Forecasting by Statistical Inferences. Irving I. Gringorten. *Journal of Meteorology*, Vol. 7, No. 6, December, 1950, pp. 388–394, illus. 10 references.

On Stochastic Interpolation of Omitted Observation. M. Ogawara. *Papers in Meteorology and Geophysics*, Vol. 1, No. 1, October, 1950, pp. 50–57. 4 references.

Radiative Heat Transfer in the Air Near the Ground. E. L. Deacon. *Australian Journal of Scientific Research, Series A, Physical Sciences*, Vol. 3, No. 2, June, 1950, pp. 274–283, illus. 12 references.

The Formation of Rain by Coalescence. E. G. Bowen. *Australian Journal of Scientific Research, Series A, Physical Sciences*, Vol. 3, No. 2, June, 1950, pp. 193–213, illus. 16 references.

Statistical Explanation of Spontaneous Freezing of Water Droplets. Joseph Levine. *U.S., N.A.C.A., Technical Note No. 2234*, December, 1950. 27 pp., illus. 7 references.

Correspondence: Preliminary Experimental Results Concerning Charge Generation in Thunderstorms Concurrent with the Formation of Hailstones. H. K. Weickmann and H. J. aufm Kampe. *Journal of Meteorology*, Vol. 7, No. 6, December, 1950, pp. 404, 405. 3 references.

An Experimental Research of Evaporation from a Circular Dish. S. Ooi. *Papers in Meteorology and Geophysics*, Vol. 1, No. 1, October, 1950, pp. 133–147, illus. 11 references.

A Theory of Annual Temperature Variations. Thomas A. Gleeson. *Journal of Meteorology*, Vol. 7, No. 6, December, 1950, pp. 351–362, illus. 22 references.

Some Possible Effects of Solar-Radiation Changes on the Annual Pressure Oscillation. Jerome Spar. *Journal of Meteorology*, Vol. 7, No. 6, December, 1950, pp. 395–397, illus. 2 references.

On the Method of Computing Vertical Motion in the Atmosphere. Y. Masuda. *Papers in Meteorology and Geophysics*, Vol. 1, No. 1, October, 1950, pp. 1–28, illus. 4 references.

Dynamics of the Movement of Atmospheric Vortices. M. Magata. *Papers in Meteorology and Geophysics*, Vol. 1, No. 1, October, 1950, pp. 38–44.

Transformation of the Equations of Motion in Dynamical Meteorology to Orthogonal Curvilinear Coordinates. H. Arakawa. *Papers in Meteorology and Geophysics*, Vol. 1, No. 1, October, 1950, pp. 45–49. 3 references.

Correspondence: Potential Shear, A Suggested Conservative Property in Equatorial Meteorology. H. Arakawa. *Journal of Meteorology*, Vol. 7, No. 6, December, 1950, p. 404.

On the Formation of Shear Lines in the Upper Atmosphere. Yi-Ping Hsieh. *Journal of Meteorology*, Vol. 7, No. 6, December, 1950, pp. 382–387, illus. 4 references.

Possible Effects of Ozonosphere Heating on Sea-Level Pressure. H. Wexler. *Journal of Meteorology*, Vol. 7, No. 6, December, 1950, pp. 370–381, illus. 24 references.

A Preliminary Quantitative Analysis of Precipitation Mechanisms. Henry G. Houghton. *Journal of Meteorology*, Vol. 7, No. 6, December, 1950, pp. 363–369, illus. 10 references.

Observational Studies of Convection. Joanne Starr Malkus, Andrew F. Bunker, and Kenneth McCasland. *Soaring*, Vol. 14, No. 5-6, May-June, 1950, pp. 13, 15. Observational procedure and results of studies on cumulus clouds and thermals at the Woods Hole Oceanographic Institution during the Summer of 1949.

A "Geostrophic Map." Archie F. Williams. *American Meteorological Society, Bulletin*, Vol. 31, No. 9, November, 1950, pp. 315–317, illus.

Map Analysis in the Vicinity of a Pressure Jump. John C. Freeman, Jr. *American Meteorological Society, Bulletin*, Vol. 31, No. 9, November, 1950, pp. 324, 325, illus. 4 references.

On the Intensities and Altitudes of the Night-Sky Light. H. Simamura and I. Ichimura. *Papers on Meteorology and Geophysics*, Vol. 1, No. 1, October, 1950, pp. 153–160, illus. 12 references.

On the Visibility in the NW-Pacific. H. Arakawa. *Papers in Meteorology and Geophysics*, Vol. 1, No. 1, October, 1950, pp. 58–66, illus.

Military Aviation (24)

The California Plan; Mobilizing Civil Air Power for Maximum Utilization in an Emergency. *Southern Flight*, Vol. 34, No. 6, December, 1950, pp. 16, 17, 33.

Navigation (29)

Radar Will Be Primary Traffic Control Aid. William D. Perreault. *American Aviation*, Vol. 14, No. 23, December 25, 1950, pp. 32–35, illus. Report of the Operational Policy Group of the Air Coordinating Committee's Navigation Panel.

New Radar for Airport Control. *The Aeroplane*, Vol. 79, No. 2056, December 15, 1950, pp. 552, 553, illus.

Description of the Airfield Control Radar to be installed at London Airport and used in conjunction with the Microwave Early Warning Radar installation.

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Ordnance & Armament (22)

Fighter Armament. V—Lessons from the Luftwaffe. A. R. Weyl. *Flight*, Vol. 58, No. 2185, December 7, 1950, pp. 535–537, illus.

Photography (26)

Photographic Determination of the Orientation of a Rocket. L. W. Fraser and R. S. Ostrander. *Photographic Engineering*, Vol. 1, No. 4, October, 1950, pp. 105–118, illus. 2 references.

Development of the method. The position of the camera in space can be determined from a photograph that contains two or more identifiable landmarks. The orientation of the rocket is derived by means of a model that contains the fixed angular relationship of the camera to the rocket in which it is mounted.

An Iconoscope Electro-Optical Shutter for High-Speed Photography. H. A. Prime and R. C. Turnock. (*I.E.E., Measurements Section, Paper No. 1067.*) *Institution of Electrical Engineers, Proceedings, Part II, Power Engineering*, Vol. 97, No. 60, December, 1950, pp. 793–796, illus. 9 references.

The application of television techniques to high-speed photography. The system uses an iconoscope tube in which the photoemission is controlled by the application of suitable potentials to the collector electrode. The charge image, formed during a chosen interval, is stored on the mosaic and subsequently scanned. Examples of exposures of various duration down to 2×10^{-5} sec. are shown. The mechanisms of spurious image formation during the "shutter-closed" period are discussed. The performance of the system is compared with that of a Kerr cell.

A High Intensity Short Duration Spark Light Source. J. A. Fitzpatrick, J. C. Hubbard, and W. J. Thaler. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1269–1271, illus. 2 references.

A high-intensity light source with an effective duration of 10^{-7} sec. is obtained by using a coaxial cable with silver conductors. The dielectric, which forms the body of the cable, is compounded of barium titanate. The cable length is 16.5 cm.

Shadowgrams of Spherical Missiles Entering Water at Supersonic Speeds. J. H. McMillen, R. L. Kramer, and D. E. Allmand. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1341, 1342, illus.

A Photographic Method for Displacement/Time Recording. F. M. Bruce. *British Journal of Applied Physics*, Vol. 1, No. 11, November, 1950, pp. 291–293, illus. 4 references.

The image of a point source of light produced by a small spherical reflector is formed on the surface of a moving body. The motion of the reflector is recorded on a continuous-feed or rotating-drum camera in the form of a sharply focused continuous line giving a displacement-time record that can be read directly.

Simultaneous Photography of Self-Luminous and Non-Self-Luminous Effects. John S. Rinehart. *Review of Scientific Instruments*, Vol. 21, No. 11, November, 1950, pp. 939, 940, illus. 2 references. A technique for the simultaneous use of streak photography and microsecond multiflash techniques.

Hand-Held High Speed Motion Picture Camera. Bernard Marcus. *Photographic Engineering*, Vol. 1, No. 2, April, 1950, pp. 57–62, illus. 3 references. Characteristics and operation of the German Rotax high-speed camera with a continuously variable speed range of 24–600 frames per sec.

Study of Deformation at High Strain Rates Using High-Speed Motion Pictures. Herbert I. Fusfeld and Josephine Carr Feder. *American Society for Testing Materials, Bulletin*, No. 170, December, 1950, pp. 75–79, illus. 2 references.

Method for studying the geometry of deformation processes at drawing speeds. A shadow technique is used for measuring the strain and shape of the neck during high-speed tension tests.

Camera Frames Low-Level Flight Data. *Aviation Week*, Vol. 54, No. 1, January 1, 1951, p. 25, illus.

A camera developed by Douglas Aircraft Co. which has a semicircular glass grid located between the camera lens and film. Horizontal lines on the grid represent 2°; the vertical included angle is 10°; the horizontal angle is 160°, which is the limit of the camera tracking range. This "Photoscope" camera acts as a photographic transit; it is placed on a line perpendicular to the flight path. Accurate leveling is done by a transit-type tripod.

The Application of Radar to Geodetic Surveying. J. Warner. *Australian Journal of Applied Science*, Vol. 1, No. 2, June, 1950, pp. 133–146, illus. 9 references.

Discussion on "Shoran—An Electronic Tool for Surveying and Mapping" by J. L. Rannie. B. G. Ballard. *Engineering Journal*, Vol. 33, No. 11, November, 1950, pp. 982–984, illus.

Power Plants

JET & TURBINE (5)

Behavior of an Experimental Combustion Chamber at Reduced Pressures. Stewart Way and R. L. Hundstad. (*American Society of Mechanical Engineers, 71st Annual Meeting, November 26–December 1, 1950, New York, Preprint No. 50-A-112.*) *Westinghouse Electric Corporation, Westinghouse Research Laboratories, Scientific Paper No. 1557*, November 13, 1950. 31 pp., illus. 3 references.

A study of a simple can-type combustion chamber handling a petroleum distillate fuel in the pressure range of 4–20 lbs. per sq.in. absolute was made to determine the losses at low pressures. The liquid fuel was injected into the combustion chamber through a 7.5 gal. per min. swirl atomizer. Tests were also run using a 2.25 gal. per min. swirl atomizer.

The Reheat Factor in Turbines and Turbocompressors; New Formulae for Calculating the Factors for Units with Finite Stages Based on Known Methods Used on the Infinite Stage Assumption. J. Kestin. *Aircraft Engineering*, Vol. 22, No. 262, December, 1950, pp. 361–367, illus. 10 references.

Theoretical Analysis of Various Thrust-Augmentation Cycles for Turbojet Engines. Bruce T. Lundin. *U.S., N.A.C.A., Report No. 981*, 1950. 17 pp., illus. 4 references. U.S. Govt. Printing Office, Washington. $0.20.

Analysis of principles and operation of tailpipe burning, water injection, and bleedoff methods of thrust augmentation. Curves show the effects of the design and operating variables of each system on the thrust and fuel consumption of the engine.

General Algebraic Method Applied to Control Analysis of Complex Engine Types. Aaron S. Boksenbom and Richard Hood. *U.S., N.A.C.A., Report No. 980*, 1950. 12 pp., illus. 2 references. U.S. Govt. Printing Office, Washington. $0.15.

The Development of a Hollow Blade for Exhaust Gas Turbines. H. Kohlmann. (*ZWB, Untersuchungen und Mitteilungen Nr. 788*, December, 1943.) *U.S., N.A.C.A., Technical Memorandum No. 1289*, December, 1950. 51 pp., illus. 3 references.

Suitable profiles for the blades were developed by cascade studies. Cascade efficiency was defined on the basis of the lift and drag terms from airfoil theory. The turbine blading was laid out on the basis of cascade theory, and Joukowsky profiles were used as the blade sections. Calculating methods are developed for obtaining information about the temperature distribution over the blade and in the blade shank and root. Manufacturing techniques were developed simultaneously with the design calculations.

Pulsating Jet Engines—A Survey of the Development of Ignition. P. Schmidt. (*Verein deutscher Ingenieure, Zeitschrift*, Vol. 92, No. 16, June 1, 1950, pp. 393–399.) *The Engineer's Digest*, Vol. 11, No. 11, November, 1950, pp. 378, 379, illus.

Extended Lift of Propeller Turbine Engines. R. N. Dorey. (*S.A.E., National Aeronautic Meeting, New York, April 17–20, 1950, Preprint.*) *Esso Air World*, Vol. 3, No. 2, September–October, 1950, pp. 34–41, illus.

Turbojet Engines—Service Experience. John W. Bailey. *SAE Journal*, Vol. 51, No. 12, December, 1950, pp. 23–25, illus. (Excerpts from a paper.) Allison J35 and J33.

A Starter for Turbines. *The Aeroplane*, Vol. 79, No. 2055, December 8, 1950, pp. 514–516, illus., cutaway drawing.

The starter, developed by Rotax, Ltd., consists of a small turbine driven by a gas discharge from a cordite cartridge. The unit was developed for use on the de Havilland Ghost turbojet.

"Lesser Flea" Turbine-Starting; Some Observations on the AiResearch Pneumatic System. Stanley H. Evans. *Flight*, Vol. 58, No. 2185, December 7, 1950, p. 534, illus.

Jets Ablaze. Howard A. Klein. *Aero Digest*, Vol. 61, No. 6, December, 1950, pp. 30, 31, 68–70, illus. Fire hazards and fire preventive measures in jet aircraft.

Development of the Turboprop; British and American Units and the Aircraft in Which They Are Installed. *Flight*, Vol. 58, No. 2184, November 30, 1950, pp. 489–497, illus.

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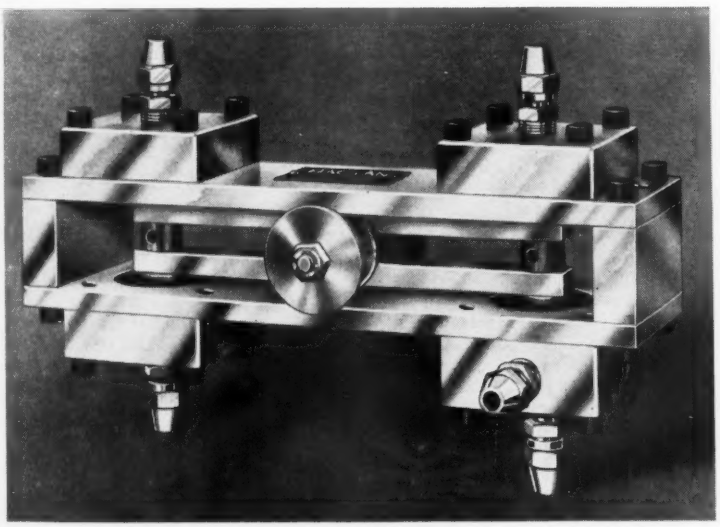

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Sapphire (Armstrong-Siddeley) Turbojet Development. Paul H. Wilkinson. *Aviation Age*, Vol. 14, No. 6, December, 1950, pp. 30, 31, illus.

RECIPROCATING (6)

Thermal Stresses in a Piston and Cylinder of an Air Cooled High Speed Internal Combustion Engine (Aero-Engine). I—Summary, Introduction and Thermal Stresses in a Piston. G. Broersma. *Indonesia, Office for Scientific Research, Publication No. 17*, August 7, 1950. 20 pp., illus. 30 references.

Derivation of formulas relating stress and temperature in a piston. A general treatment is developed for the thermal stress. Radial and tangential stresses occur in the piston crown; axial and tangential stresses occur in the piston skirt. In the computation of the stresses in the cylinder, the stress patterns are calculated for the cooling fins without the cylinder and for the cooling fins with an infinitely long cylinder. The resulting solution is a series of equations; each equation represents the solution for one cooling fin.

Observation of the Lubricating Oil Film Between Piston Ring and Cylinder of a Running Engine; The Effects of Ring Geometry. R. L. Brooks and M. L. Atkin. *Australia, Department of Supply and Development, Aeronautical Research Laboratories, Report No. E66*, May, 1950. 21 pp., illus. 5 references.

A qualitative method of studying the oil film involved measuring the electrical contact resistance between the top piston ring and cylinder wall of a running engine. A cathode-ray oscillograph measured the potential drop between the ring, which was insulated from the rest of the piston, and the cylinder wall, when a small fixed potential was applied through a known series resistor. A single-cylinder P. & W. Wasp H air-cooled engine was used. Torsion and taper-faced rings, rings with chamfered edges, and the effect of ring bearing area were studied.

How to Cool Pistons. Frank Jardine. *SAE Journal*, Vol. 51, No. 12, December, 1950, pp. 52–55, illus. (Based on a paper: Piston Cooling and Ring Groove Wear).

The Supercharging of Internal Combustion Engines. I, II. Harry R. Ricardo. *The Engineer*, Vol. 190, Nos. 4948, 4949, November 24, December 1, 1950, pp. 501, 502; 519–522, illus. Analysis of the supercharging process; comparison of advantages of supercharging in aircraft engines, racing cars, and the four-cycle diesel.

Investigation of a Systematic Group of NACA 1-Series Cowlings with and Without Spinners. Mark R. Nichols and Arvid L. Keith, Jr. *U.S., N.A.C.A., Report No. 950*, 1949. 100 pp., illus. 7 references. U.S. Govt. Printing Office, Washington. $0.55.

Studies in the Langley propeller-research tunnel of cowling-spinner combinations based on the N.A.C.A. 1-series nose inlets to obtain systematic design data for one family of approximately ellipsoidal spinners.

Calculation of Stresses in Connecting Rods. H. Parkus. (*Maschinenbau und Wärmewirtschaft*, Vol. 5, No. 9, September, 1950, pp. 152–157.) *The Engineer's Digest*, Vol. 11, No. 11, November, 1950, pp. 387–390, illus. 1 reference.

A method is developed for calculating the nominal stresses at the weakest cross sections of the connecting rod. The actual extreme values of the stress on the rod can be obtained by multiplication with the corresponding stress-concentration factors. The process is applied in a sample calculation of the stresses on a connecting rod at a speed of 2,200 r.p.m.

Power-Plant Installation of the AG-14 Pusher. Ben Anderson and Marvin Greenwood. *Aeronautical Engineering Review*, Vol. 10, No. 2, February, 1951, pp. 31–36, illus. 3 references. Installation problems of the Continental C-90 engine mounted on a pusher on the Anderson-Greenwood AG-14 personal airplane.

More Power for the Gipsy Queen 70. *de Havilland Gazette*, No. 59, October, 1950, p. 8, illus.

ROCKET (4)

Three Equations for Rapid Calculation of Rocket Motor Thrust. Hermann Oberth. *British Interplanetary Society, Journal*, Vol. 9, No. 6, November, 1950, pp. 275–278.

Rockets and R.A.T.O. A. V. Cleaver. *Flight*, Vol. 58, No. 2184, November 30, 1950, pp. 482–484, illus. (Digest of a paper.)

Production (36)

An Improved Casting Process with Resin-Sand Moulds. H. W. Perry. *Aircraft Engineering*, Vol. 22, No. 262, December, 1950, pp. 371, 374, illus.

This process uses molds made of a dry mixture of sand and a phenolic resin baked on a cast-iron pattern as a thin shell. Long baking and curing times are unnecessary, but the mold can be used only once. This method was applied by the Bakelite Div. of Union Carbide & Carbon Corp. on a process developed by Johannes Croning.

Optical System Developed for Building Large Jigs and Fixtures. Gilbert P. Muir. *The Tool Engineer*, Vol. 25, No. 6, December, 1950, pp. 24, 25, illus.

A method developed by Republic Aviation Corp. for erecting large tooling for aircraft structures which uses (British) Taylor-Hobson optical instruments and knock-down German jig-assembly castings. The system sets up beams of light as reference lines instead of using mechanical devices, and, in combination with adequate positioning equipment, coordinates the fixture matching points with the established lines of sight or light beams. The apparatus permits working to an accuracy of 0.0015 in. in a 50-ft. vertical or horizontal span, and to 6 sec. of angle.

Optical Tooling Eases Airframe Building. *Aviation Week*, Vol. 53, No. 24, December 11, 1950, pp. 23, 25–29, illus. A method developed by Republic Aviation Corp. for erecting large tooling for aircraft structures.

Aircraft Riveting. H. Giddings. *Royal Aeronautical Society, Journal*, Vol. 54, No. 480, December, 1950, pp. 753–778, illus.

A discussion from the standpoint of the structural designer. The functions of a riveted joint are reviewed, and the various types of rivets are compared in their characteristics and applications. Other topics investigated include fatigue and loading characteristics of each type, rivet weights, and comparative costs.

Airspeed Ambassador. V—Wing Centre-Section and Outer-Plane Tooling and Assembly. *Aircraft Production*, Vol. 12, No 146, December, 1950, pp. 351–354, illus.

Production Engineering, Administration and Management. VII. J. V. Connolly. *Aircraft Engineering*, Vol. 22, No. 262, December, 1950, pp. 368–370. 15 references. Production control processes.

Split-Second Planning. Willard L. Landers. *Aero Digest*, Vol. 61, No. 6, December, 1950, pp. 20–22, 74–76, 82, illus. Fairchild's Industrial Mobilization Planning Program and its application to the production of the C-119.

Manufacturing Research Advises: To Buy or Not to Buy—To Save. R. Brut Schulze. *The Martin Star*, Vol. 9, No. 12, December, 1950, pp. 14, 15, 19, illus.

The Glenn L. Martin Co. uses a method of economic analysis to determine if the company should install new equipment. Strict economic control governs every purchase, and all factors (utilization, length of time the equipment is expected to last, advantages over present equipment, estimates of future production needs) are considered before any purchase is made.

Stretch-Wrap Forming. II—British Practice in the Use of the Hufford Machine. *Aircraft Production*, Vol. 12, No. 146, December, 1950, pp. 334–340, illus.

Radius-Forming; Ingenious Wheel-Dressing Device for Small, Concave and Convex Arcuate Forms. *Aircraft Production*, Vol. 12, No. 146, December, 1950, p. 333, illus.

Machining Blower-Casings; Single-Location Fixture for Maintaining Close Tolerances on Godfrey Units. *Aircraft Production*, Vol. 12, No. 146, December, 1950, pp. 331–333, illus.

Heat Treatments; Their Selection and Specification in Design. III—Combination Hardness and Toughness. Norman N. Brown. *Machine Design*, Vol. 22, No. 12, December, 1950, pp. 137–142, illus.

Short-Run Piercing; Adaptable, Template-Controlled Machine for Small- and Medium-Quantity Production. *Aircraft Production*, Vol. 12, No. 146, December, 1950, pp. 357–359, illus.

The Weldability of Chromium-Molybdenum Steels; Steel Composition and Arc Welding Procedure. H. F. Tremlett. *Institute of Welding, Transactions*, Vol. 13, No. 3, October, 1950, pp. 143–156, illus.

Welding Electrodes and Rods—for Ferrous and Nonferrous Metals. H. R. Clauser. (Materials & Methods Manual No. 65.) *Materials & Methods*, Vol. 32, No. 6, December, 1950, pp. 67–82, illus. 2 references.

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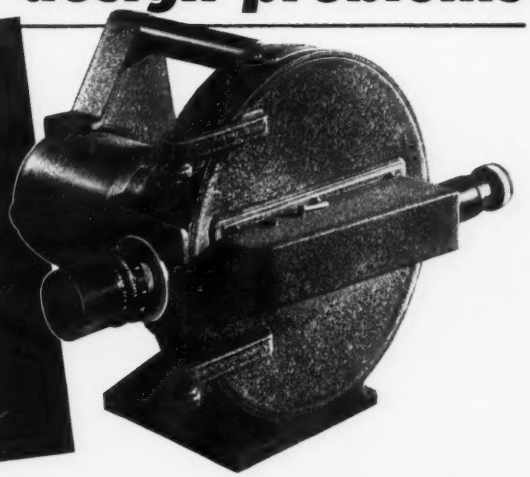

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Experiments for the Determination of the Influence of Residual Stresses on the Fatigue Strength of Structures. M. Roš. *Institute of Welding, Transactions*, Vol. 13, No. 5 (*Welding Research*, Vol. 4, No. 5), October, 1950, pp. 83r–93r, illus. 8 references.

A Review of Recently Published Information on the Spot Welding of Light Alloys. P. M. Teanby. *Institute of Welding, Transactions*, Vol. 13, No. 5 (*Welding Research*, Vol. 4, No. 5), October, 1950, pp. 94r–102r, illus. 31 references.

Reports of International Welding Commissions. *Institute of Welding, Transactions*, Vol. 13, No. 5, October, 1950, pp. 135–141. Reports of commissions on resistance welding, documentation, terminology, standardization, weldability, residual stresses and stress relieving, and brittle fractures.

An Investigation of the Copper Brazing of Steel. C. J. Osborn and S. T. M. Johnstone. *Australia, Department of Supply, Aeronautical Research Laboratories, Report No. SM. 159*, August, 1950. 15 pp., illus. 16 references.

Split-Block Construction; Multiple Method of Manufacturing Wood Details. J. C. Reussner. *Aircraft Production*, Vol. 12, No. 146, December, 1950, pp. 341, 342, illus.

The process consists essentially of making each part in the form of a wood block and using slices of these blocks to build the finished details. It is suitable for thin components since the depth of the parts is limited by the size that can be cut on a saw (about 12 in.). Synthetic-resin glues are used to assemble the finished parts. The process was developed by Slingsby Sailplanes, Ltd. and is used by them in the manufacture of gliders.

Scientific Packaging. *Aircraft Production*, Vol. 12, No. 146, December, 1950, pp. 343–348, illus. Design and construction of special packings for the shipment of aircraft components.

Propellers (11)

Investigation of a Systematic Group of NACA 1-Series Cowlings with and Without Spinners. Mark R. Nichols and Arvid L. Keith, Jr. *U.S., N.A.C.A., Report No. 950*, 1949. 100 pp., illus. 7 references. U.S. Govt. Printing Office Washington. $0.55.

Studies in the Langley propeller-research tunnel of cowling-spinner combinations based on the N.A.C.A. 1-series nose inlets to obtain systematic design data for one family of approximately ellipsoidal spinners.

Rotating Wing Aircraft (34)

Theoretical Analysis of Oscillations in Hovering of Helicopter Blades with Inclined and Offset Flapping and Lagging Hinge Axes. M. Morduchow and F. G. Hinchey. *U.S., N.A.C.A., Technical Note No. 2226*, December, 1950. 31 pp., illus. 3 references. Derivation and analysis of the frequency and damping characteristics of the coupled flapping and lagging oscillations.

Helicopters, Present and Future. Igor I. Sikorsky. *Aeronautical Engineering Review*, Vol. 10, No. 2, February, 1951, pp. 37, 38, illus.

Hoppi-Copter MK 2. C. Colin Copper. *American Helicopter*, Vol. 20, No. 11, October, 1950, pp. 6, 7, illus.

Sciences, General (33)

MATHEMATICS

Numerical Determination of Fundamental Modes. Donald A. Flanders and George Shortley. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1326–1332, illus. 2 references.

A method for the numerical determination of the fundamental eigenfunction and eigenvalue in linear eigenvalue problems. The procedure is based on the use of a network and difference equations, but it is not an iterative process. A polynomial operator is applied to the trial function once to accomplish a degree of reduction in all eigenfunctions other than the fundamental. The process is applied in two and three dimensions.

Determination of Eigenvalues Using a Generalized Laplace Transform. Morris D. Friedman. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1333–1337. 6 references.

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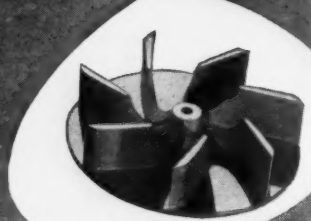

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Readers' Forum: Generalized Complex Forces in Flutter Calculations. J. E. V. Nilsson and N. B. Langefors. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, p. 139. 1 reference.

Readers' Forum: A Simple Graphical Solution of the Duhamel Integral. E. V. Laitone and J. T. Ahlin. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 142, 143, illus. 2 references.

Real Roots of Real Dirichlet L-Series. J. Barkley Rosser. *U.S., National Bureau of Standards, Journal of Research*, Vol. 45, No. 6, December, 1950, pp. 505–514, illus. 8 references. (Also available as *Research Paper No. 2165*. U.S. Govt. Printing Office, Washington. $0.10.)

The Fundamental Solution of Linear Elliptic Differential Equations with Analytic Coefficients. Fritz John. *Communications on Pure and Applied Mathematics*, Vol. 3, No. 3, September, 1950, pp. 273–304. 16 references.

The Partial Differential Equation $u_t + uu_x = \mu_{xx}$. Eberhard Hopf. *Communications on Pure and Applied Mathematics*, Vol. 3, No. 3, September, 1950, pp. 201–230, illus. 2 references.

Estimation of the Error at a Point on a Least-Squares Curve. P. G. Guest. *Australian Journal of Scientific Research, Series A, Physical Sciences*, Vol. 3, No. 2, June, 1950, pp. 173–182, illus. 7 references.

Marginal Checking as an Aid to Computer Reliability. Norman H. Taylor. *Institute of Radio Engineers, Proceedings*, Vol. 38, No. 12, December, 1950, pp. 1418–1421, illus. 6 references.

Marginal checking uses performance margins to establish the life expectancy of components so that those with low margins can be removed during the testing period. Marginal checking varies voltages in logical circuit groups, inducing inferior parts to cause failure, while a test program or pulse transmission detects and localizes potential failure. In a digital computer, this can be automatically accomplished with the computor itself acting as the detector.

Project Typhoon Aids Missile Designers; New Electronic Computer Can Solve Problems of Entire Defense System. David A. Anderton. *Aviation Week*, Vol. 53, No. 25, December 18, 1950, pp. 40, 42, illus.

Typhoon is an electronic computer that can compute the motions of any projectile through any medium. The computer was developed by a joint program of the Special Devices Center of the Office of Naval Research and Radio Corporation of America.

A Digital Electronic Correlator. Henry E. Singleton. *Institute of Radio Engineers, Proceedings*, Vol. 38, No. 12, December, 1950, pp. 1422–1428, illus. 9 references.

The relationship between correlation functions and the general theory of communication leads to a technique of electronic computation of correlation functions and to the design of a binary digital machine for this purpose.

Predicting Phase Behavior with Digital Computers. T. J. Connolly, S. P. Frankel, and B. H. Sage. *Electrical Engineering*, Vol. 70, No. 1, January, 1951, p. 47. 7 references. (Digest of a paper.)

PHYSICS

Gas Evolution in Liquids and Cavitation. P. H. Schweitzer and V. G. Szebehely. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1218–1224, illus. 3 references.

An investigation of cavitation phenomena by testing the air solubility and the rate of solution and evolution of air (when the liquid is disturbed from its equilibrium condition) of nine heavy lubricating oils, four light lubricating oils, three aircraft-engine fuels, one diesel fuel, and distilled water. The theory of the cavitation process and of the relation between cavitation and gas evolution are reviewed. Formulas are derived for the rate of evolution of the gas; an expression is obtained for the half-life of evolution (the time required for the evolution of one-half of the total evolved gas).

Space Travel

Electromagnetic Launching as a Major Contribution to Space-Flight. Arthur C. Clarke. *British Interplanetary Society, Journal*, Vol. 9, No. 6, November, 1950, pp. 261–267, illus. 3 references.

The Optimum Velocity. Hermann Oberth. (*Wege zur Raumschiffahrt*, Munich, 1925, Part 2, Chapter 8, pp. 62–83.) *Rocketscience*, Vol. 4, No. 4, December, 1950, pp. 75–80, illus.

Structures (7)

Calculation of Thermal Stresses in a Wedge-Shaped Wing. George H. Eisenhardt and Warren M. Rohsenow. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 115–123, illus. 2 references.

Derivation of a procedure for computing the thermal stresses of a solid symmetric double-wedge steel wing at an altitude of 50,000 ft., at a Mach Number of 1.4, and with a temperature distribution of 531.6°F. absolute. The wedge is subjected to uniform acceleration at a rate of one Mach Number per 30 sec. at $M = 1.4$–6.0. Thermal stresses are calculated on the wing at $M = 6.0$ and on the wing root, which is solidly built into the fuselage.

A Numerical Method for the Stress Analysis of Stiffened-Shell Structures Under Nonuniform Temperature Distributions. Richard R. Heldenfels. *U.S., N.A.C.A., Technical Note No. 2241*, November, 1950. 45 pp., illus. 3 references.

The Effect of Nonuniform Temperature Distributions on the Stresses and Distortions of Stiffened-Shell Structures. Richard R. Heldenfels. *U.S., N.A.C.A., Technical Note No. 2240*, November, 1950. 50 pp., illus. 15 references.

Three-Dimensional Photoelasticity. A. J. Durelli and R. L. Lake. *Machine Design*, Vol. 22, No. 12, December, 1950, pp. 122–125, illus. 2 references.

A new method of studying creep in materials. The test specimen is subjected to a period of loading at room temperature. Photographs are taken of slices of the material after the loading period. The fringe patterns on the photographs indicate the stress distribution in the material.

Structural Measurements on Complex Aircraft Components Using Strain-Gage Summation Circuits. Maurice A. Walter. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 101–106, illus. 5 references.

Electric strain gages are used for the simple measurement of net loads on an airfoil surface of complex structure without previous knowledge of the load distribution. A summation electric strain-gage circuit measured the net incremental load through a single electric output signal. Air load is obtained by correlating the net load with inertia effects. Properly located strain-gage circuits were electrically combined into a simple bridge circuit to make the signal output independent of load distribution, enabling shear and bending moments to be determined.

The Design Approximation of Skin Thickness from Stiffness Criteria. A. H. Hall. *Royal Aeronautical Society, Journal*, Vol. 54, No. 480, December, 1950, pp. 741–752, illus. 2 references.

A general approach to the problem of estimating wing thickness from preliminary design data is indicated in a manner that allows for easy calculation. Only symmetric sections are considered although the procedure can be extended to cover cambered sections.

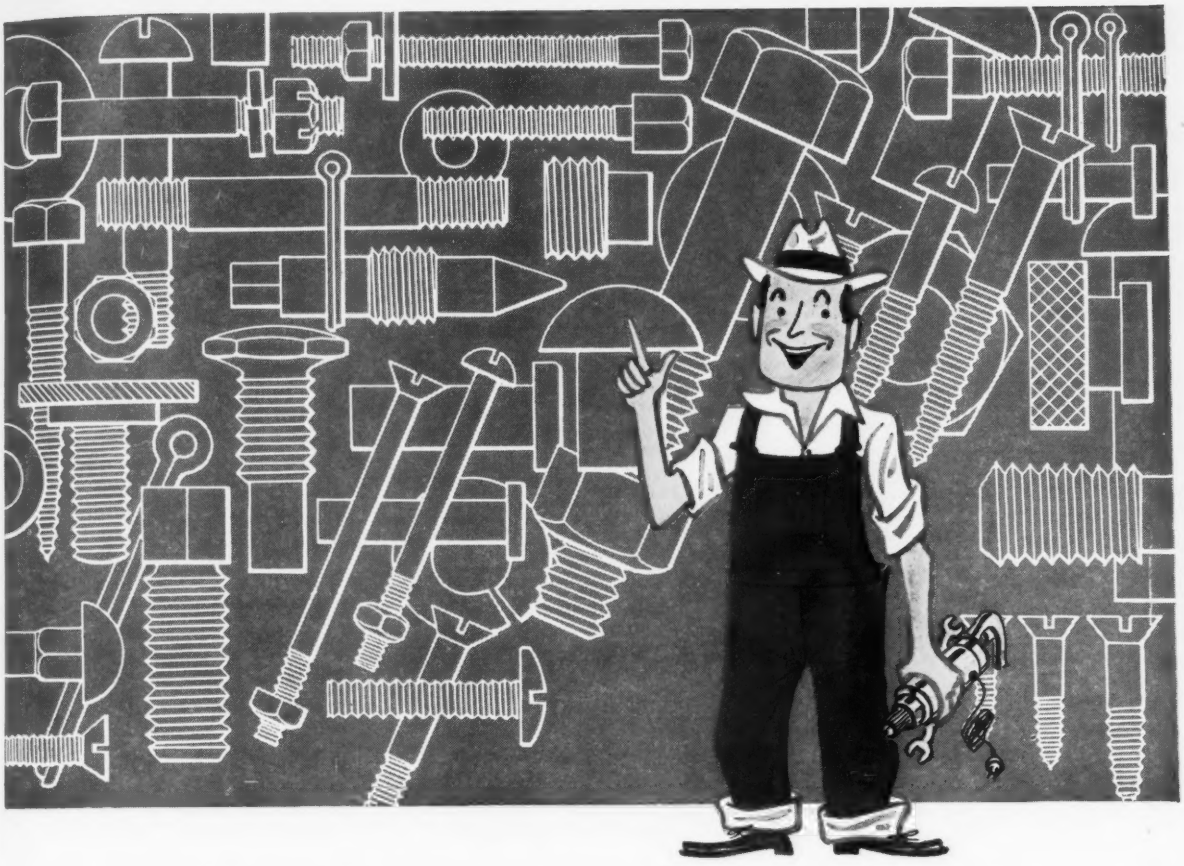
Readers' Forum: Generalized Complex Forces in Flutter Calculations. J. E. V. Nilsson and N. B. Langefors. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, p. 139. 1 reference.

Vibrations of Elastic Systems Having Hereditary Characteristics. Enrico Volterra. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 363–371, illus. 20 references.

Determination of the hereditary function of a material having hereditary characteristics from the study of its forced vibrations. In the hereditary state, the deformation depends on all the stresses that have been applied to an elastic body rather than on the actual applied stress. The problems connected with hereditary characteristics are solved by integrodifferential equations.

Beam Vibrations with Time-Dependent Boundary Conditions. R. D. Mindlin and L. E. Goodman. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 377–380. 6 references.

Development of a method for the solution of the problem of the flexural vibration of beams. A general process is derived for removing the time-dependence from the boundary conditions.



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Some Notes on the Analysis of Redundant Systems by Means of the Conception of Conservation of Energy. T. M. Charlton. *Franklin Institute, Journal*, Vol. 250, No. 6, December, 1950, pp. 543–551. 10 references.

Measurements of Diffraction of Shock Waves and Resulting Loading of Structures. Walker Bleakney, D. R. White, and W. C. Griffith. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 439–445, illus. 4 references.

Explanation of experimental methods of studying diffraction phenomena. Waves of large amplitude are generated in shock tubes. Interferograms are made both in the still air and in the disturbed flow, and contours of fringe shifts are plotted. The principal forces can be measured as a function of time, and the loading can be determined.

Vibration of Rectangular Plates by the Ritz Method. Dana Young. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 448–453, illus. 13 references.

Tables of values of the functions that define the normal modes of vibration of a uniform beam have been computed. Values of the integrals of the functions and their derivatives have also been computed and tabulated. These data are used to set up the equations for the plate deflection. Solutions are then obtained for three specific plate problems.

Some Developments of Expansion Methods for Solving the Flutter Equations. John Williams. *The Aeronautical Quarterly*, Vol. 2, Part 3, November, 1950, pp. 209–225, illus. 8 references.

A procedure for obtaining bivariate expansions and univariate expansions (X assigned) in the case where the number of degrees of freedom is so large that direct expansion of the stability determinant becomes too complex. A method of bivariate expansion which uses a framework in which all the intersections are inside the flutter quadrant is applied to a quaternary wing-flutter problem. Single-entry tables should be constructed for the application of the framework to flutter problems.

The Solution of Problems in Plane Strain by Fourier Series. F. S. Shaw. *Australia, Department of Supply and Development, Aeronautical Research Laboratories, Report No. SM. 152*, June, 1950. 18 pp., illus. 4 references.

For simply connected rectangular regions, exact solutions are derived for the stress components that result from general systems of applied edge tractions. The tractions can be represented by Fourier series.

Analysis of Plane-Stress Problems with Axial Symmetry in Strain-Hardening Range. M. H. Lee Wu. *U.S., N.A.C.A., Technical Note No. 2217*, December, 1950. 79 pp., illus. 25 references.

A method of solution is developed based on the deformation theory of plasticity, using the concept of finite strain. The method is applied to the cases of a circular membrane under pressure, a rotating disc with and without a hole, and an infinite plate with a circular hole, and the results are analyzed.

Torsional Stress Concentration in Angle and Square Tube Fillets. J. H. Huth. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 388–390, illus. 2 references.

Determination of the shearing-stress concentration at the fillet of an angle subjected to uniform torsion. Results are given of previous investigations that were carried out by using the soap-film analogy or analytically. These results show a wide variation. New results are obtained for angle sections and thin-walled square-tube sections by means of the relaxation method. These new results are also at variance with the earlier results.

Elastic Torsion in the Presence of Initial Axial Stress. J. N. Goodier. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 383–387, illus. 13 references.

St. Venant's solution for ordinary torsion is extended to the problem of torsion in the presence of initial axial stress with any distribution in the cross section.

On the General Theory of Thin Shells. W. R. Osgood and J. A. Joseph. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 396–399, illus. 4 references.

Buckling Load of a Stepped Column. Frederick M. Hoblit. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 124–126, illus. 2 references.

A procedure is developed for computing the critical buckling load of a column having a finite number of steps with constant EI within each step. The procedure is applicable to columns with any end conditions and with loads applied within the span as well as the ends.

Torsion and Flexure of a Uniform Beam with Cross-Section Bounded by Two Circular Arcs. M. MacVean and J. Guest. *Australia, Department of Supply, Aeronautical Research Laboratories, Report No. SM. 156*, June, 1950. 29 pp., illus. 2 references.

Exact solutions are obtained for St. Venant's flexure and torsion problems. The flexure problem was solved by the Laplace transformation method; the solution of the torsion problem was obtained with the conjugate torsion function ψ.

The Stresses Around a Small Opening in a Beam Subjected to Pure Bending. J. A. Joseph and J. S. Brock. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 353–358, illus. 5 references.

Derivation of an exact closed solution for the stress distribution around a small opening in the web of a beam that is subjected to pure bending. The complex-variable method of solution is used and applied to a general ovaloid opening.

Natural Frequencies of Continuous Beams of Uniform Span Length. R. S. Ayre and L. S. Jacobsen. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 391–395, illus. 4 references.

The frequency of any mode of a beam of any number of equal spans is determined by a graphic network method. The pattern of frequency of the continuous beam must first be established Results are accurate to three significant figures.

Impact on a Multispan Beam. W. H. Hoppmann, II. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 409–414, illus. 6 references.

Development of the deflection equation for the central impact on a three-span beam. The bending strains may be obtained by differentiating the deflection equation twice with respect to the position coordinate. The method can be extended to the case of a beam on any number of supports.

Beams on Elastic Supports and on Cross-Girders. J. M. Klitchieff. *The Aeronautical Quarterly*, Vol. 2, Part 3, November, 1950, pp. 157–166, illus. 2 references.

The method, which is not limited to the cases of equally spaced supports of equal rigidities, expresses the deflection curve of the beam in the form of a trigonometric series. The solution is then obtained in the form of a rapidly converging series. If applied to the problem of beams supported by cross-girders, the solution is reduced to a system of linear equations; the number of equations equals the number of cross-girders.

Effect of Stress-Free Edges in Plane Shear of a Flat Body. W. T. Read. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 349–352, illus. 1 reference.

Determination of the tangential stiffness of a rectangular body (shear pad) with a uniform relative tangential displacement on the upper and lower surfaces. The edges of the pad are stress-free. The stiffness was obtained as a function of the shear modulus, Poisson's ratio, and the relative dimensions of the pad. Upper and lower bounds are developed for the stiffness through the use of simple energy relations and an approximate energy method.

Discussion: Longitudinal and Torsional Impact in a Uniform Bar with a Rigid Body at One End by A. H. Burr. Alexander Yorgiadis and E. H. Lee. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 462–465, illus. 5 references.

Thermodynamics (18)

Preliminary Investigation of Heat Transfer to Water Flowing in an Electrically Heated Iconel Tube. Samuel J. Kaufman and Francis D. Isely. *U.S., N.A.C.A., Research Memorandum No. E50G31*, September 27, 1950. 34 pp., illus. 2 references.

An experimental investigation to obtain surface-to-fluid heat-transfer information. For conditions in which no boiling occurred, good correlation of average heat-transfer coefficients was obtained by the use of the Nusselt relation; runs made in the nucleate-boiling region gave higher values of the heat-transfer coefficient than were obtained with the Nusselt relation.

Correlations of Heat-Transfer Data and of Friction Data for Interrupted Plane Fins Staggered in Successive Rows. S. V. Manson. *U.S., N.A.C.A., Technical Note No. 2237*, December, 1950. 14 pp., illus. 5 references.

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A Comparison of Theory and Experiment for High-Speed Free-Molecule Flow. Jackson R. Stalder, Glen Goodwin, and Marcus O. Creager. *U.S., N.A.C.A., Technical Note No. 2244*, December, 1950. 68 pp., illus. 19 references.

A comparison of free-molecule flow theory with results of wind-tunnel tests on a transverse circular cylinder of 0.0031-in. diameter to determine the drag and temperature-rise characteristics. The model was constructed of butt-welded iron and constantan wires. Test conditions corresponded to a Mach Number range of 0.55–2.75 and Reynolds Number range of 0.005–0.90.

Temperature Distribution in a Steady, Laminar, Preheated Air Jet. Chia-Shun Yih. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 381, 382. 2 references. Exact solution for the temperature distribution for the two-dimensional and axially symmetric cases.

A Discussion on Detonation. *Royal Society (London), Proceedings, Series A, Mathematical and Physical Sciences*, Vol. 204, No. 1076, November 22, 1950, pp. 1–33, illus. 43 references.

Contents: Introduction, W. G. Penney. Similarity Solutions to Problems Involving Gas Flow and Shock Waves, Geoffrey Taylor. Theoretical Considerations Relating to the Detonation of Solid Explosives, H. Jones. Some Characteristics of Detonation, W. M. Evans. Pressure Measurements in Detonating Gases, R. M. Davies, J. D. Owen, D. H. Edwards, and D. E. Thomas. Two New Streak Cameras, C. A. Adams. The Initiation of an Explosion and Its Growth to Detonation, F. P. Bowden. The Physical Chemistry of Detonative Reactions, A. R. Ubbelohde. A New Photographic Method for Studying Fast Transient Phenomena, J. S. Courtney-Pratt. Some Comments on the Contribution by Dr. Courtney-Pratt, A. R. Ubbelohde. The Reduction in Reaction Energy in Cases of Incomplete Confinement, S. Paterson. High and Low Detonation Velocity Regimes in Condensed Explosives, J. Taylor. The Fading of Detonation in Solid Explosives, O. A. Gurton.

Water-Borne Aircraft (21)

Water-Based Fighters; An Outline History and a Survey of Modern Possibilities. H. F. King. *Flight*, Vol. 58, No. 2186, December 14, 1950, pp. 551–555, illus., cutaway drawing.

Wind Tunnels & Research Facilities

Time Lag in the Self-Nucleation of a Supersaturated Vapor. Ronald F. Probstein. *Princeton University, Aeronautical Engineering Laboratory, Report No. 168*, November 27, 1950. 27 pp., illus. 12 references.

In the study of condensation of water vapor in supersonic and hypersonic wind tunnels, a discrepancy exists between the predicted and experimental results. An approximate solution is found to the nonsteady Becker-Döring equation for the self-nucleation of a supersaturated vapor to determine if the time lag associated with the approach of the steady state of formation of condensation nuclei is the cause of the disagreement between theoretical and experimental results. Included in the solution are the first approximation of the work required to form embryos of the condensing nuclei, the time lag caused by the heating of the nuclei due to bombardment by molecules of the condensing phase, and the time lag due to an accommodation coefficient for the liquid nuclei different from 1.

Wind-Tunnel Tests for Temperature Recovery Factors at Supersonic Velocities. W. F. Hilton. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 97–100, illus. 4 references.

A study of the temperature attained by an unheated body moving at supersonic speeds. The rise in temperature is due to skin friction and adiabatic compression. Temperatures were measured on the surface of a tangential ogive attached to a cylinder of 4-in. diameter at Mach Numbers of 1.73 and 2.00. The model was made of Lucite.

The Correction of Wind Tunnel Nozzles for Two-Dimensional, Supersonic Flow. R. E. Meyer and M. Holt. *The Aeronautical Quarterly*, Vol. 2, Part 3, November, 1950, pp. 195–208, illus. 6 references.

The flow in the wind tunnel is assumed to be two-dimensional, isentropic, irrotational, steady flow of a perfect gas. The corrections for the nozzle are expressed in terms of the values on the axis of the characteristic coordinates of the field of flow in the uncorrected nozzle.

Design and Performance of a Simple Interferometer for Wind-Tunnel Measurements. Harry I. Ashkenas and Arthur E. Bryson. *Journal of the Aeronautical Sciences*, Vol. 18, No. 2, February, 1951, pp. 82–91, illus. 44 references.

The design of an interferometer with a 3½-in. diameter light field and its application to a continuously operating 4- by 10-in. supersonic wind tunnel at GALCIT.

Measurements of Diffraction of Shock Waves and Resulting Loading of Structures. Walker Bleakney, D. R. White, and W. C. Griffith. *Journal of Applied Mechanics*, Vol. 17, No. 4, December, 1950, pp. 439–445, illus. 4 references.

Explanation of experimental methods of studying diffraction phenomena. Waves of large amplitude are generated in shock tubes. Interferograms are made both in the still air and in the disturbed flow, and contours of fringe shifts are plotted. The principal forces can be measured as a function of time, and the loading can be determined.

A Simple Interferometric Test for Conical Flow. J. H. Geise, F. D. Bennett, and V. E. Bergdolt. *Journal of Applied Physics*, Vol. 21, No. 12, December, 1950, pp. 1226–1231, illus. 8 references. Development of a test for conicity based directly on interferometer fringe shifts. The test is applied to data obtained from conical regions in flows about bodies in free flight.

Investigation of the Flow Through a Single-Stage Two-Dimensional Nozzle in the Langley 11-Inch Hypersonic Tunnel. Charles H. McLellan, Thomas W. Williams, and Ivan E. Beckwith. *U.S., N.A.C.A., Technical Note No. 2223*, December, 1950. 30 pp., illus. 1 reference.

Recirculating Apparatus for Testing Hygrometers. Arnold Wexler. *U.S., National Bureau of Standards, Journal of Research*, Vol. 45, No. 5, November, 1950, pp. 357–362, illus. 3 references. (Also available as *Research Paper No. 2145*. U.S. Govt. Printing Office, Washington. $0.10.)

An apparatus suitable for research and calibration of electric hygrometers produces atmospheres of known relative humidity. It operates by saturating air at one temperature and then raising the air temperature sufficiently to give a specific relative humidity. The centrifugal saturator can be used above 0°C. and down to −40°C. The air is continuously recirculated in a closed system by means of four independent recirculating systems. Hygrometers can be switched from one system to another by a pneumatic valve.

The Carlat Helicopter. *Flight*, Vol. 58, No. 2184, November 30, 1950, pp. 484, 485, illus. A 1,500-lb. test machine for investigating the preliminary characteristics of a wing that has, in the leading edge, a narrow full-span slot venting upwards.

The Sylvanus Albert Reed Award

(*Continued from page 9*)

viously unavailable, aerodynamic information. Much of this information is not obtainable at the present time by any other method. Through Mr. Gilruth's conception and application of these techniques, a most important fund of new knowledge is being created which is currently being used in the rational design of transonic and supersonic aircraft required for the security and welfare of the U.S.

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(*Continued from page 9*)

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Mr. Piasecki is President of the American Helicopter Society and a member of the Helicopter Subcommittees of both the N.A.C.A. and the S.A.E. Last summer, he was elected to the Chairmanship of the Helicopter Council, Aircraft Industries Association of America, Inc.

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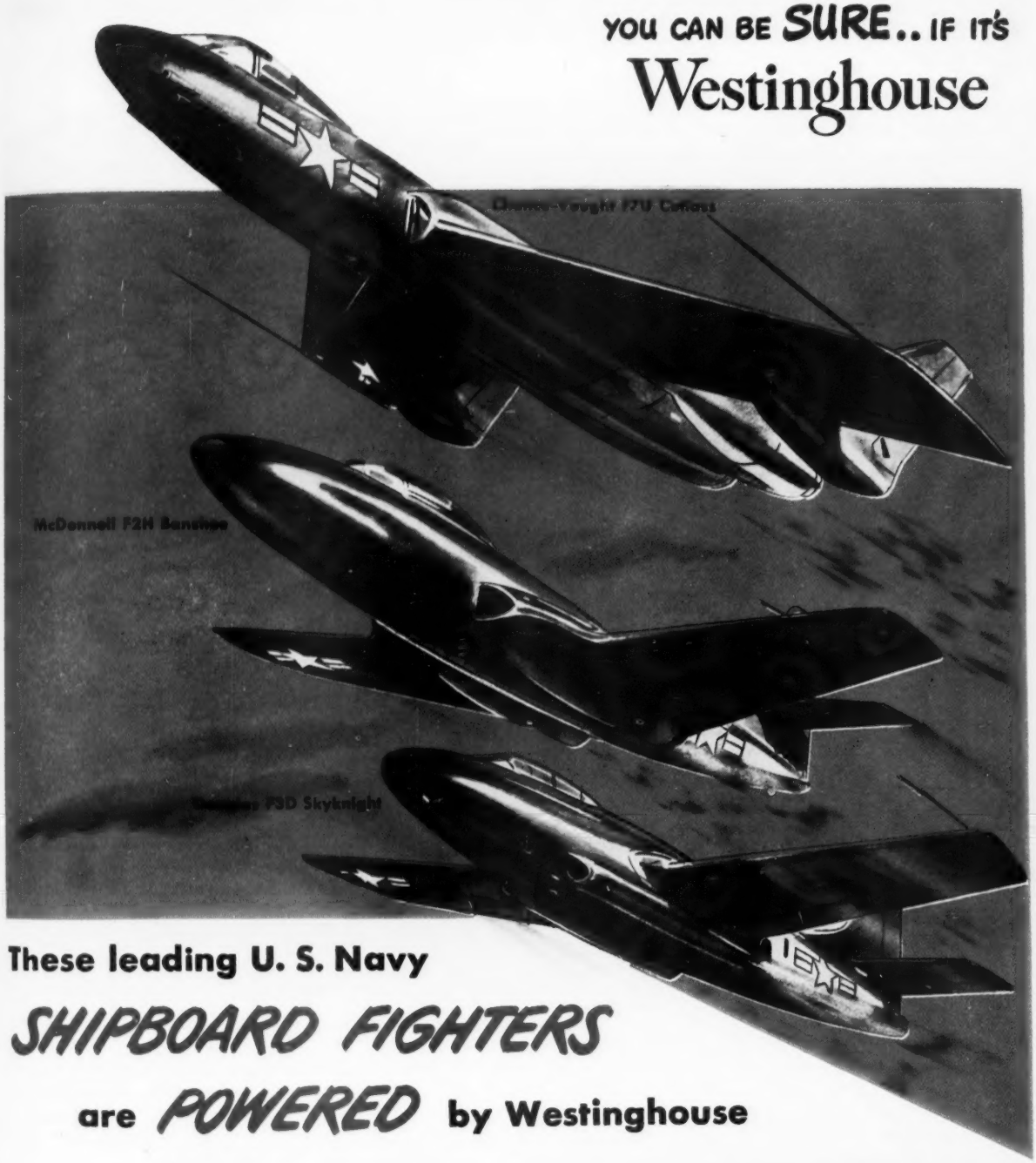

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Aeronautical Reviews — BOOKS

Refuelling in Flight

By C. H. Latimer-Needham. London, Sir Isaac Pitman & Sons, Ltd.; New York, Pitman Publishing Corporation, 1950. 191 pp., figs. $4.00.

This book presents rather comprehensively the economic fundamentals of refueling in flight which may be applied to commercial and military airplanes.

It starts with a complete history of refueling in flight from the earliest experiments in 1923 in the United States to the present day. It points out, oddly enough, that the only fatal accident during the course of any in-flight refueling operation occurred in the first year of experimentation—namely, in 1923.

It is an analytical book that deserves the serious study of the aircraft designer and air-line engineer engaged in long-range aircraft design and operation.

The author makes the interesting observation that, despite the vast oceanic expanses that cover approximately two-thirds of the earth's surface, it is possible to connect any two large traffic-generating centers by flights averaging 3,000 miles in length and with little deviation.

The second chapter, which deals with the economics of flight refueling, is well written. It emphasizes the basic advantages of in-flight refueling, which are: (1) maximum pay load permissible (as limited by zero fuel weight); (2) higher block-to-block speeds allowed by the elimination of refueling stops, which the author points out are not always properly placed; and (3) the resultant increase in the revenue-producing ability.

This reviewer questions the additional safety on take-off. Should in-flight refueling become an accepted procedure for long-range operation, the aircraft designer will quickly proceed to reduce air-frame drag by decreasing wing area to meet minimum regulations and thus gain more speed.

Furthermore, while it is admitted that range has in the past dictated aircraft size for economic reasons, it does not necessarily follow that in-flight refueling will result in the use of smaller aircraft for overseas operation. It indicates that aircraft size can then be guided by traffic potential requirements rather than range, as it is done with domestic operating requirements.

Fuel reserves for jet aircraft appear to be overemphasized since power-plant improvements will substantially reduce fuel consumption. Of greater importance, although not brought out in this book, is the lack of available space with thin high-speed wings for the storage of sufficient fuel for long flights, which makes refueling in flight extremely desirable for this type of operation.

In the third chapter, specifications for four types of flight-refueled aircraft are outlined, using basically the same air frame and pay load, but varying the empty and take-off weights to adjust for the various types of power plants applied and their fuel weights. This analysis, which is made for three pay-load capacities equivalent to 50, 75, and 100 passengers, is extremely conservative.

Much thought has been given to whether or not in-flight refueling should be done. By a thorough and interesting analysis of various routes and an analysis of costs, the author provides useful methods for the study of the question.

The military economics of refueling in flight is most extensively analyzed and serves to emphasize flight refueling as a long-range operational weapon.

Perhaps the only question this reviewer has on the author's analysis of this problem is the overrating of flight refueling as a means of expediting the turn-around of fighter aircraft, since, in a great many cases, ammunition would also have to be replenished on the ground.

In-flight refueling equipment and methods of operation are well described and illustrated.

The book concludes with developments in the technique of flight refueling, and the list of references provides a useful adjunct.

The author, being Chief Engineer of Flight Refueling, Ltd., speaks authoritatively on the subject, and this book merits the attention of anyone interested in long-range aircraft operation.

CHARLES FROESCH
Chief Engineer
Eastern Air Lines, Inc.

For information on I.A.S. Library Service Facilities, see page 47

Statements and opinions expressed in Book Reviews are to be understood as individual expressions and not necessarily those of the Institute.

The Mathematical Theory of Plasticity

By R. Hill. London and New York, Oxford University Press, 1950. 356 pp., figs. $7.00.

The publishers of this book have provided an excellent short summary of its contents, and this will be quoted below as an introduction to this review.

"The theory of plasticity is a young science. The book has been written to introduce the subject to engineers and applied mathematicians as a rewarding field for study and research. Stress-strain relations, laws of yielding and work-hardening, extremum and uniqueness theorems are developed systematically, with particular attention to the physical basis. Several chapters are given to analyses of the stresses and strains in technological processes such as rolling, forging, and drawing, with especial care for the interests of designers in industry. The correct approach to plastic problems is illustrated by numerous examples, including indentation, autofrettage, and the non-uniform distortion of plates and bars. The treatment of all subjects is taken to the limit of present knowledge, and much new material is published for the first time."

If the reactions of most engineers are similar to those of the reviewer, it is doubtful whether much of the information in this book will find its way into engineering calculations, at least for a long time. In the preface the author acknowledged the fact that many engineers will be unfamiliar with the suffix notation used, and he has provided an appendix that explains the mathematical shorthand involved. This is in itself a useful feature of the book—in fact, indispensable to anyone not familiar with

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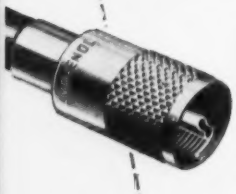

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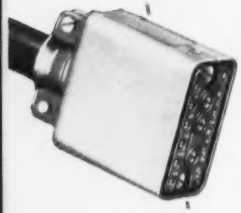

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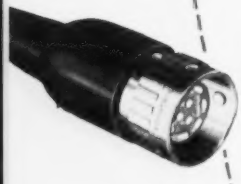

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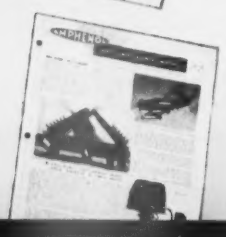

tensor notation, invariants, etc. The engineer's difficulty with a book of this type comes from the fact that the treatment progresses "downward" from a high level of mathematical generality and rigor, through a series of simplifying assumptions (made necessary by the fact that the mathematical complications become too great), finally tapering off with some practical problems at a mathematical level that just begins to interest the practicing engineer. Perhaps the greatest advantage derived from this approach is that it clearly establishes the nature and probable effect of the assumptions made. The disadvantage is that most of the people who could make direct use of the information are unable to follow the author down the path to the point of actual application for the simple reason that they have never been to the top.

The book should be most valuable to research workers in the field of plasticity, not only because of its thorough mathematical treatment but also because of the large number of references. As to the publishers' statement that "the treatment of all subjects is taken to the limit of present knowledge," the author more modestly refers to his knowledge of papers appearing in scientific journals before the autumn of 1949.

Much of the book deals with the "plastic-rigid" case, in which the elastic component of strain is neglected and for which the shear stress is assumed to be constant (no work hardening). The earlier chapters include descriptions of the various theories of inelastic behavior, including the idea of "effective stress" and brief descriptions of the theories of Hencky, Swainger, and Prager. It is unfortunate that the theory of Batdorf and Budiansky (*N.A.C.A. Technical Note No. 1871*) was not available at the time the book was written; the assumptions underlying this new theory seem to be more realistic than those of previous theories of inelastic behavior.

PROFESSOR F. R. SHANLEY
Department of Engineering
University of California
at Los Angeles

Report on the Machinability Research Program

Increased Production, Reduced Costs, Through a Better Understanding of the Machining Process, and Control of Materials, Tools, Machines. Program sponsored by the U.S. Air Force. Wood-Ridge, N.J., Curtiss-Wright Corporation, 1950. 162 pp., illus., diagrs.

In the months to come the hive will throb with intensive planning activity. A key question will be productivity and producibility. The capacity of the machine tool to produce is a dominant factor in product design, tool design, and the myriad steps

of production. Such fundamentals, similar to the fundamentals of blocking and tackling in football, are susceptible to review even with the most experienced of teams.

For this reason a hearty welcome indicated by wide use should be accorded to this small report. It has food for the most experienced and yet is usable by the greenest beginner.

For the experienced, it will point out again the growing importance of premachining heat treatment, especially in the tougher materials. Metal condition at the end of forming is not necessarily metal condition suited to the easiest machinability. Obviously, such a state is emphasized when the metal in question is not easily machinable at best.

For the beginner, the sections on the function of the various tool angles will be easily understood and stimulating. The diagrams are exceptionally clear. The text is concise, well-arranged, and supplemented by well-chosen and well-prepared graphic material.

For both groups of readers, this report should contribute to an integrated understanding of the complex factors that make for greater, cheaper production. It does not pretend to answer all the questions. One of its great merits is the questions that it raises and the procedure that it suggests for answering them.

To those who might object to the frequent stress on metal microstructure, page 155 has a ready answer. Here six photos of SAE 8640 show clearly the enormous changes produced in a single material by heat treatments. The text in this section is suggestive of the wide applications that may result from the project.

These are only six chapters. The first, "How to Analyze the Machining Process," is a brief but complete guide to the whole approach. For the beginner, especially, this is a valuable introduction to methods in this rapidly changing field.

Chapter Two, "Metals Under the Microscope," approaches an understanding of physical metal microstructure without unnecessary delving into their origins.

The third chapter on tool testing and selection has thoughtful suggestions for production trouble shooting on both new and existing machine tools. In aids in bringing science to the help of art in machine operation. In a situation where the experience that makes art is lacking, such an approach may become a necessity.

The remaining three chapters describe the application of this approach to the problem of securing optimum production in three materials. Jet-engine alloys, cast iron, and SAE 8640 are studied in turn. Production planners should find good material here. The book notes that only urgent need has forced the general release of some of this new material.

ENGINEERS NOTEBOOK

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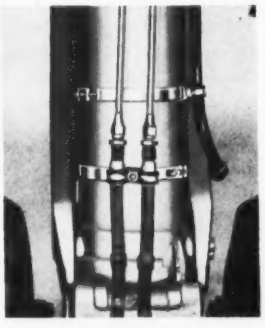
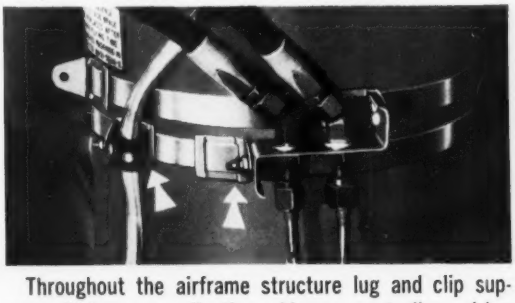


Marman support clamps perform an infinite variety of tasks. The lug support clamp illustrated fastens hydraulic lines to the main landing gear on a large bomber. It is ideally suited for applications where a highly stressed machined part prohibits the use of welded lugs.

The clip support shown below accomplishes a similar purpose except that it holds hydraulic lines farther away from the strut and provides a lighter assembly with slightly less strength. Its use may be preferred where many such supports are required on one ship.



Throughout the airframe structure lug and clip supports find many applications. Line support clips, wiring harness clips, attachment of ducting, are just a few of the many light duty installations for which they are suited.

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The work should call attention again to points that have been argued in the past. More attention, consistent with end-product demands, should be given to getting metal into the plant in its most machinable condition. Another point that every such analysis raises is: "What should be the standard of machine tool efficiency?" The valuable stimulus that a purely theoretical standard gave to the development of heat engines should not be ignored. All too often, our standards are backward looking. Their obvious value is to keep us from getting worse, but they are small help in getting better. Something of the order of cubic inches per hour must eventually become the standard at which to aim. The setup must obviously take time out of cutting, but we shall never improve the set-up method if we don't have a nagging standard way ahead to urge us.

Certainly finish and a host of other things must be considered. Recent years have shown that there is nothing inherently inconsistent in high finish and high production rates.

The Air Force and the many organizations concerned in the production of this report deserve great credit for the excellent presentation of the material. All too often, fine work has been marred in the last step of its communication to the interested public.

JAMES L. G. FITZPATRICK
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Book Notes

AIRPORTS

Highway Research Board, Proceedings of the 29th Annual Meeting, 1949. Washington, Division of Engineering and Industrial Research, 1950. 620 pp., illus., diagrs.

Forty-five original research papers on highway engineering are presented, including discussions of design, materials of construction, maintenance, traffic and operations, and soils. Papers and reports presented for separate publication are listed.

ELECTRONICS

Joint A.I.E.E.-National Telemetering Forum Conference on Telemetering, Philadelphia, May 24-26, 1950. New York, American Institute of Electrical Engineers, 1950. 207 pp., illus., diagrs. $3.50.

Contents: Historical Highlights and Early Work of the A.I.E.E. in Electrical Telemetering, P. A. Borden. Historical Sketch of the National Telemetering Forum and Mobile or Radio Telemetry, W. J. Mayo-Wells. Radio Telemetering Methods and Terminology, J. F. Brinster. Accuracy Concepts in Telemetering, E. E. Lynch and H. C. Thomas. Functional Classification of Telemetering Systems, W. H. Burnham. The Application of Electrical Telemetering in the Transmission and Distribution of Natural Gas, W. E. Rufleth. Some Pulse Telemetering Systems Developed at the Naval Research Laboratory, K. M. Uglow, Jr. Telemetering in a Large Interconnected Power System, C. K. Duff. API. FM/FM System, J. W. Hamblen. A

High-Speed Telemetering System with Automatic Calibration, W. E. Phillips. Aeronautical Telemetering, M. V. Kiebert, Jr. Applications of Rectified Current to Telemetering on a Two-Conductor Circuit, F. E. Uehling. Telemeter Computing Systems for Industrial Process Functions, A. J. Hornfeck. An Electromechanical Transducer, J. F. Engelberger and H. W. Kretsch. Specialized Problems in Rocket Telemetering, Marcus O'Day. Telemetering at Glenn L. Martin Company, J. M. Pearce. A Multichannel PAM-FM Radio Telemetering System, J. P. Chisholm, B. F. Buckley, and G. W. Farnell. Radiosonde Telemetering, L. E. Wood. Special Transducers for Basic Parameter Electric Conversions, C. A. Dyer. Unbonded Strain Gage Telemetering Pickups, Gifford White. Temperature Pickups and Their Use with Magnetic Amplifiers, V. C. Westcott. The Sun as a Primary Reference for Internal Instrumentation of Rockets, L. M. Biberman. The Metrotype System of Digital Recording and Telemetering, G. E. Foster. Data Recording and Automatic Reduction System for Telemetering, G. O. Hall. A Semi-Automatic Method of Reducing Telemetered Oscillogram Data, H. B. Dickinson. High-Speed Multichannel Switching, D. E. Woodbridge. Problems of Telemetry Data Analysis, B. S. Benson. Performance Results of the Ampex Magnetic Tape Recorder: Recording Frequency Modulated and Pulse Width Telemetering Data, M. J. Stolaroff.

Frequency Modulated Radar. David G. C. Luck. New York, McGraw-Hill Book Company, Inc., 1949. 466 pp., figs. $4.00.

Based on research and development work at the RCA Laboratories beginning in 1938, and continued after 1941 under U.S. Navy auspices, this book is intended to cover the field of frequency-modulated radar for those already familiar with the techniques of radio engineering, pulse radar, and servomechanisms. The first part covers Principles of Operation, Radio Apparatus Used in F-M Radar Data, and Motion of Aircraft and Missiles. Part 2, on Applications, deals with single-target systems for altitude and speed measurement, automatic bombing, rocket firing, including accessory circuits and methods of calibration. Developmental single-target systems for range-only rocket firing, target tracking, vertical speed measurement, and bombing in vertical maneuvers are then treated. Multiple target search systems are discussed in the final chapter. References to original reports and papers are included at the ends of chapters.

Proceedings of the National Electronics Conference, Volume V (1949). Chicago 19, National Electronics Conference, Inc., 852 E. 83rd St., 1950. 581 pp., illus., diagrs. $4.00.

Contents: Closed Cycle Recording Oscillographs, Ben Ciscel and Roman Ruhland. D-C Amplifier Techniques in Oscillography, M. Maron. Low Frequency Noise in Transistors, Howard T. Mooers. Experimental Examination of Rectifier Theory As Applied to the Selenium Rectifier, H. W. Henkels. The Photoformer in Anacom Calculation, H. W. Schultz, J. F. Calvert, and E. L. Buell. Linear Electronic Analog Computer Design, C. A. Meneley and C. D. Morrill. Bone Density Computing Machine, Walter N. Brown, Jr. A Pulse Length Sorter and Counter, R. J. Parent and R. W. Schumann. Thickness Gauge for Moving Material, Stephen V. Hart and Irving W. Rozian. Multiple Channel Cathode Ray Instrumentation of Non-Electrical Quantities, J. N. Van Scoyoc and G. F. Warnke. A Computer for Solving Secular Equations, John F. Storm. Coordinate Tubes for Use with Electrostatic Storage Tubes, R. S. Julian and A. L. Samuel. Electronic Analogue for Heating System Analysis, Ralph T. Squier, Ben Ciscel, and Kimball C. Cummings. A Universal-Application Cathode-Ray Sweep Transformer with Ceramic Iron Core, C. E. Torsch. A New Image Orthicon, R. B. Janes, R. E. Johnson, and R. R. Handel. Two New Television Tuners, M. F. Melvin. End-Loaded and Expanding Helices as Broad Band Circularly Polarized Radiators, Paul W. Springer. Im-

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Electronics, Experimental Techniques. William C. Elmore and Matthew Sands. New York, McGraw-Hill Book Company, Inc., 1949. 417 pp., diagrs. $3.75.

This volume was originally prepared as a manual for use by the Los Alamos Scientific Laboratory and the Manhattan Project. The main part of the book describes circuits in five general categories: Voltage Amplifiers, Electronic Counters, Oscillographs and Associated Equipment, Test and Calibration Equipment, and Power Supplies and Control Circuits. Cir-

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cuit elements most used are described in a useful separate chapter. Circuit components and construction practice are discussed in the first chapter. The authors are Associate and Assistant Professors of Physics, respectively, at Swarthmore College and the Massachusetts Institute of Technology.

Television Receiving Equipment. W. T. Cocking. 3rd. Ed. London, Published for "Wireless World" by Iliffe & Sons, Ltd., 1950. 375 pp., illus., diagrs. 18*s*.

In this new edition of a book first published in 1940 and last revised in 1946, a large amount of new material is added, including new chapters on deflector coils and selectivity and fuller treatments of electromagnetic deflection and synchronizing. The chapter on radio-frequency amplication is followed by two chapters covering the points of difference between radio-frequency and signal-frequency amplification. Most mathematical expressions have been removed from the text and placed in the various appendixes.

Microwave Electronics. John C. Slater. New York, D. Van Nostrand Company, Inc., 1951. 406 pp., diagrs. $6.00.

A logical development of the subject is presented, with enough detail to make the book complete enough for a textbook. Material relating to magnetron and reflex klystron oscillators and their related circuits is largely from the author's wartime work for the M.I.T. Radiation Laboratory and the Bell Telephone Laboratories. Publication was delayed, however, until such postwar developments as particle accelerators, the linear accelerator, and the traveling-wave amplifier could be included. A brief but useful history of the subject is given in the preface. Dr. Slater is Head of the Department of Physics at the Massachusetts Institute of Technology.

ENGINEERING

Engineering Growth and Engineering Education. John P. Nielsen. New York, The Author, College of Engineering, New York University, 1950. 72 pp., diagrs.

Professor Nielsen's finding is that the steady growth in size and complexity of the engineering field is a normal and healthy process. The parallel growth and diversification of engineering curricula should be further encouraged by engineering colleges. It is pointed out that knowledge is mounting in complexity by geometrical progression. A national engineering society representing all practicing engineers is recommended, with which the Engineers' Council for Professional Development should associate itself. Schools are recommended to work on 20-year programs, adjusting curricula at the ends of those periods in accordance with engineering long-term trends. The growth of engineering is illustrated graphically in figures showing the field at 20-year intervals, beginning in 1870 with 7,000 civil engineers, of whom about 800 were mining engineers. In 1950 there were 350,000 engineers in over 50 fields, including 15,000 aeronautical engineers. The picture in 1970 is vastly more complicated. The chart shows 30,000 aeronautical engineers in 1970.

The Engineering Profession. Theodore Jesse Hoover and John Charles Lounsbury Fish. 2nd Ed. Stanford, Calif., Stanford University Press, 1951. 486 pp., diagrs. $5.50.

The Engineering Method. John Charles Lounsbury Fish. Stanford, Calif., Stanford University Press, 1951. 186 pp., diagrs. $3.00.

The Engineering Profession was first published in 1941. The present edition is larger by 45 pages, including revisions of the discussions of municipal, ceramic, construction, heat-transfer, and electronics engineering. Thirty-nine new tables have been added, on salaries and the functional, industrial, and geographic distribution of engineering (published also in *The Engineering Profession in Transition* by Andrew Fraser, New York, 1947.) The principal changes are in the chapters on the five branches (with subdivisions) of engineering which are discussed. Chapters on the profession of engineering and education remain largely unchanged. Aeronautical engineer-

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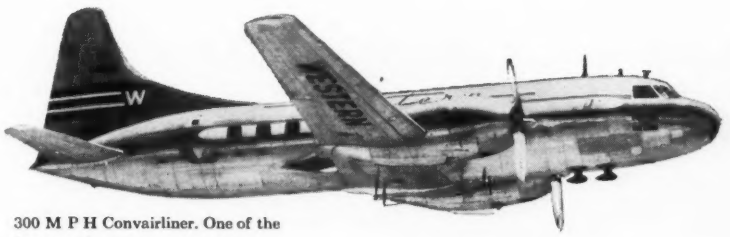

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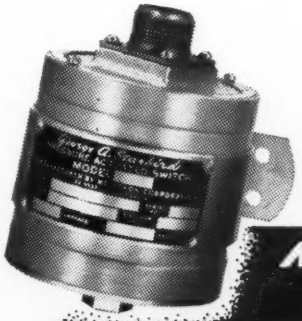

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ing is discussed in no particular detail as a branch on transportation equipment under mechanical engineering. The functional aspects of engineering in general are well handled.

The Engineering Method is a separate publication of chapters 9, 10, and 11 (pages 217-399) of *The Engineering Profession*. It presents a thoughtful and detailed discussion of the reasoning process, followed by a chapter on applications and ending with an excellent treatment of Uncertainties in Engineering. Illustrative examples are generously supplied.

Survey of Selected Engineering Personnel. Volume I, Report. Volume II, Definitions: Occupational Specialties in Engineering. Prepared for the Department of Defense by The American Society of Mechanical Engineers for the Engineers' Joint Council. New York, Engineers' Joint Council, September 14, 1950. 25, 119 pp., charts.

The report outlines the procedures followed and the work done in making the survey. Replies are analyzed geographically by countries. Questionnaires were mailed to about 100,000 members of 18 American engineering societies, and replies were received from about 25 per cent. The second part, containing definitions, describes about 250 specialties within broad fields of engineering.

MANAGEMENT & FINANCE

Handbook of Cost Accounting Methods. J. K. Lasser, Ed. New York, D. Van Nostrand Company, Inc., 1949. 1,344 pp., diagrs. $12.

In this useful handbook, the principles and practice of cost accounting are presented according to a practical arrangement. Section I consist of 22 chapters (409 pages) covering basic principles and practices, including discussions and illustrative charts on costs of production, pricing, labor, profit and loss statements, and detailed treatments of methods of analysis and control, reporting techniques and procedures, systems of costing, government experience and costing, and variation from standards. In the second section the art of cost accounting is applied to 61 industries. Aircraft Manufacturing is discussed by Roy A. Stark, Chief Cost Accountant, Max Factor & Company, Hollywood, and formerly Supervisor of Standard Cost and Estimated Cost, Beech Aircraft Corporation. Airplane Engine Production is discussed by Roger A. Seebe, formerly Plant Auditor, Wright Aeronautical Corporation. A typical chapter on an industry covers in detail the products and their development, sources of material, plant organization, and the production order system. Design of the cost system and variance accounts are treated in particular detail, with examples of forms. A comprehensive bibliography, arranged according to chapters in the book, refers to books, articles, and pamphlets and includes references to other industries, such as air lines.

The AMA Handbook of Wage and Salary Administration. Edited by M. Joseph Dooher and Vivienne Marquis. New York, American Management Association, 1951. 412 pp., diagrs. $7.50.

This handbook presents a complete survey of wage and salary administration, both principles and techniques. The experience of management in different industries is presented by 24 authors, who are from universities and associations as well as representative companies. The opening parts cover basic principles and approaches, conducting the wage survey, and two extended reports of case histories, the Atlantic Refining Company and the General Electric Company. The next seven chapters are devoted to compensation methods for salaried jobs; then supervisory and executive salary administration is discussed in two chapters. Geographic problems, methods of setting up and operating job evaluation programs, and keeping them up to date are next discussed. Examples of forms and methods of simplifying programs conclude the book.

The Foreman's Production Job. A. L. Kress and T. O. Armstrong. New London, Conn.,

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National Foremen's Institute, Inc., 1950. 152 pp., illus. $2.50.

The first part of this book takes up fundamentals of industrial management and the relation of the foreman to the factory's organization and operation, including maintenance, production control, methods and quality control, costs, budget, and the standard hour plan. Part 2 takes up these and such additional functions as accident prevention and industrial relations as discussed in supervisors' meetings, presenting a check list of points on getting out production which have been considered important by foremen. Mr. Kress, author of Part 1, is a management consultant in New York, and Mr. Armstrong, author of Part 2, is Director of Plant Labor Relations of the Westinghouse Electric Corporation in Pittsburgh.

MILITARY AVIATION

The Air Officer's Guide. 4th Ed. Harrisburg, Pa., Military Service Publishing Company, September, 1950. 530 pp., illus. $3.50.

This is a new edition of a useful book first published in 1948 and last revised in February, 1950. Based on official publications and written by experienced officers, it includes recent legislative changes, detailed information on the organization and functioning of the U.S. Air Force, suggested procedures for both official duties and personal affairs, and factual information on such topics as Air Force bases, uniforms, the educational system, and pay and allowances.

POWER PLANTS

1950 Aircraft Spark Plug and Ignition Conference Report; Toledo, September 5, 6, 7, 1950. Toledo, Ohio, Champion Spark Plug Company, 1951. 253 pp., illus., diagrs.

Contents: Résumé of Champion Research Activities, Robert K. Christie. Water Injection and Its Effect on Ignition Performance, John Frazee. How Large Can the Gaps Be? C. E. Swanson and J. W. Miller. Aircraft Ignition Analyzers, J. W. Wheeler. Analytical Techniques and Apparatus Applicable to Examination of Combustion Chamber Deposits, G. R. Furman. Measurement of Spark Plug Temperatures, C. J. Eaton. Effect of the R-2800 Secondary Condensers As Observed on the Ignition Analyzer, E. Paul Kovac. Statistical Analysis of Spark Plug Fouling in Airline Operation, J. L. Bame. Discussions of Spark Plug Design and General Performance, Control of Operating Variables, Spark Plug Maintenance, Testing and Installation, Ignition Cables and Connectors, and Magnetos and Magneto Timing. Current Aircraft Engine Ignition Systems, Robert Boyer, Jr. Study of High Frequency Ignition System Performance (Pan American Airways System Report No. I.A 411), H. I. Mossbarger. 1950 Aircraft Spark Plug Data Chart (folded). Discussions following each paper are in numbered paragraphs for convenient finding from the index. There is also a detailed table of contents.

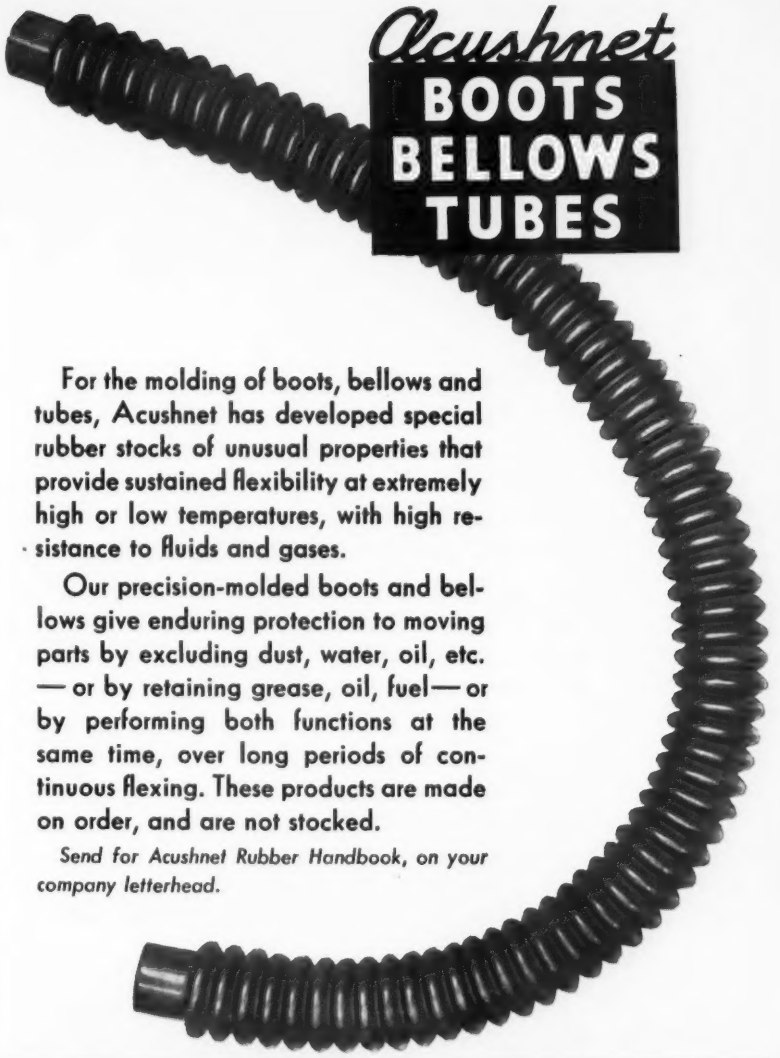
Gaseous Fluid Flow in Relation to Diesel and Internal Combustion Engine Design. New York, American Society of Mechanical Engineers, 1949. 121 pp., diagrs. $2.00.

Contents: Cooling of Spark Ignition Engines, Benjamin Pinkel. Fundamentals of Air Flow in Diesel Engine Manifolds, W. W. Hagerty and L. Talbot. Reduction of Noise of Engines, W. P. Green.

PRODUCTION

Casting Design As Influenced by Foundry Practice. Oliver Smalley. New Rochelle, N.Y., Meehanite Metal Corporation, 1950. 60 pp., illus.

The aim of this book is to present the fundamentals of the founder's art, including general design rules, pattern making, molding and core making, gates and risers, and selection of material. It is intended for the design engineer, to promote design work that is equally satisfactory to the engineering department and the foundry. Data are included on Meehanite metals.



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REFERENCE LITERATURE

BIBLIOGRAPHIES

Index of NACA Technical Publications, 1915–1949. Washington, Division of Research Information, U. S. National Advisory Committee for Aeronautics, March 31, 1950. 605 pp.

This valuable index is larger by some 200 pages than its predecessor of 1947, which it supersedes. It covers N.A.C.A. publications issued from 1915 to approximately September, 1949, including *Reports, Technical Notes, Aircraft Circulars, Wartime Reports*, and some declassified papers not in these series. In the *Wartime Report* series both the original and the *Wartime Report* number are given. Increased numbers of papers are listed on such subjects as the flow of rarefied gases, wing-body combinations of missiles, automatic control, aeroelasticity, flutter of tail tabs, parachutes, metering and control of ram-jet and pulse-jet engines and rockets, afterburning, radial and mixed flow in turbines, aftercoolers, regenerators, diagonal tension in beams, dynamic loads and stresses, and effect of nuclear radiation on materials. An index of authors is in preparation and will be issued as a supplement.

HISTORY

The Wright Brothers, Pioneers of American Aviation. Quentin Reynolds. Illustrated by Jacob Landau. New York, Random House, 1950. 183 pp., illus. $1.50.

This book is intended for younger readers. It is written in a dramatic style with a good deal of dialogue, and the events described are selective, presumably in order to simplify the story. The triumphs in Europe in 1908 and 1909, for example, are omitted, and the story ends with the successful flights at Fort Myer in 1909. The illustrations are excellent.

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SCIENCES, GENERAL

MATHEMATICS

Laplace Transformation, Theory and Engineering Applications. William Tyrrell Thomson. New York, Prentice-Hall, Inc., 1950. 230 pp., diagrs. $5.00.

The author's aim is to present the theory of the Laplace transformation and to discuss its application to various problems in engineering and physics. The idea of functional transformation and its inverse is introduced in the first chapter. Unit functions and various theorems in the second chapter add to the versatility of the method. Applications to various problems involving ordinary differential equations are next discussed, then the theory of complex variables, including arguments necessary for the inversion integral processes. Partial differential equations, difference equations, closed-loop systems, and analogies are discussed in the final chapters. Physical interpretations are included where possible, but a balance between rigor and physical insight is sought. The eight appendixes include functional operations, a table of Laplace transforms, and a list of historical and general books on the operational calculus. The author is a Professor of Mechanics at the University of Wisconsin.

The Heaviside Centenary Volume. London, The Institution of Electrical Engineers, 1950. 98 pp., illus. 10s.

Partial contents: Oliver Heaviside—the Man, George Lee. Some Unpublished Notes of Oliver Heaviside, H. J. Josephs. An Appreciation of Heaviside's Contribution to Electromagnetic Theory, Willis Jackson. Heaviside's Operational Calculus, Balth. van der Pol. Heaviside's Pure Mathematics, Harold Jeffreys. Oliver Heaviside—a Personal Sketch, G. F. C. Searle.

Interpolation. J. F. Steffensen. 2nd Ed. New York, Chelsea Publishing Company, 1950. 248 pp. $3.50.

This translation from the Danish was originally published in 1927. The author's aim is to present a textbook incorporating the increased number of available formulas with remainder terms simple enough to permit the calculation of limits to the error involved in the formula. A more rigorous point of view is followed than has been usual to distinguish between the operation of calculating the value of a function previously defined and that of inserting values in an interval where the function is not defined, accounting for the difference between a proved fact and a hypothesis. A knowledge of the first principles of differential and integral calculus is required of the reader. The author is a Professor of Actuarial Science at the University of Copenhagen.

Modern Algebra. Volume II. B. L. van der Waerden. Translated from the 2nd Revised Edition by Theodore J. Benac. New York, Frederick Ungar Publishing Company, 1951. 222 pp. $5.00.

This volume completes the translation of Professor van der Waerden's classic work, last published in Berlin in 1940. The first volume, translated by Fred Blum, appeared in 1949. Dr. Benac is Associate Professor in the Department of Mathematics at the U.S. Naval Academy.

MECHANICS

Engineering Mechanics. S. Timoshenko and D. H. Young. 3rd Ed. New York, McGraw-Hill Book Company, Inc., 1951. 517 pp., diagrs. $5.50.

This textbook was last revised in 1940. In the present edition, some advanced material contained in the authors' *Theory of Structures* (1945) and *Advanced Dynamics* (1948) is largely omitted, in order to provide a suitable undergraduate engineering textbook in statics and dynamics. The derivation of the equations of plane motion is simplified. About 300 new problems have been added, mostly of a practical engineering nature. Both authors are Professors of Engineering Mechanics at Stanford University.

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PHYSICS

Physics, Its Laws, Ideas and Methods. Alexander Kolin. New York, McGraw-Hill Book Company, Inc., 1950. 890 pp., illus., diagrs. $6.50.

This is a revision of the author's *Introduction to Physics*, published in 1948. Following a straight mathematical formulation of the laws of mechanics of points and rigid bodies, mechanics of fluids, vector fields, and heat as a form of energy, theoretical methods are introduced, establishing a logical connection, through the atomic theory of matter and electricity, between the laws of mechanics, heat, and certain electrical phenomena. A transition is then made from a mechanical wave theory of light to an electromagnetic wave theory. Finally, the inadequacy of the concrete visualizable theories of classical physics in the realm of high speeds and small dimensions leads to the development of new abstract theories capable of predicting new laws. The author is Assistant Professor of Physics in the College and in the Division of Biological Sciences at the University of Chicago.

Mathematical Engineering Analysis. Rufus Oldenburger. New York, The Macmillan Company, 1950. 426 pp., illus., diagrs. $6.00.

The author's aim is to promote facility in the expression of physical engineering situations in the form of equivalent mathematical relations. The basic laws of the mechanics of rigid bodies, electricity and magnetism, heat, elasticity, and fluid mechanics are developed from a minimum number of assumptions, as a basis for the presentation of techniques for making simplifying assumptions. A knowledge of advanced calculus, especially those aspects concerned with line, surface, and volume integrals, and of Green's and Stokes' theorems, is required of the reader. Intended as a textbook on engineering analysis and industrial physics and a reference for those engaged in industrial research, the book was developed from lectures at the Illinois Institute of Technology and DePaul University, and from work of a mathematical experimental nature at the Woodward Governor Company.

Fundamentals of Quantum Mechanics. Enrico Persico. Translated and Edited by Georges M. Temmer. New York, Prentice-Hall, Inc., 1950. 484 pp., diagrs. $8.00.

In this translation from the Italian, supplementary notes and corrections by the author have been included, and the translator has added footnotes and some amplifying sentences in the text. The bibliography includes new books in English published since about 1935 and translations of foreign language books where they exist. Professor Enrico is now Director of the Department of Physics at Laval University, Quebec, and Mr. Temmer is Research Associate, Department of Physics, University of Rochester.

Radiation Monitoring in Atomic Defense. Dwight E. Gray and John H. Martens. New York, D. Van Nostrand Company, Inc., 1951. 122 pp., illus., diagrs. $2.00.

One purpose of this excellent book is to present basic facts of atomic energy, the kinds and relative magnitudes of the hazards involved, and the fundamentals of detecting these hazards. This purpose is admirably fulfilled in Part 1, Background Information (48 pages). Discussion of the proper use and care of radiation detection instruments is undertaken in the final eight chapters. The Geiger counter, ionization-chamber survey meters, and the proportional alpha counter are the rate meters discussed. Pocket chambers and film badges are the dose meters described. There is a chapter on monitoring instruments under development, an appendix on standard calibrating sources for meters, and an excellent annotated bibliography. Dr. Gray was formerly with the Atomic Energy Commission and is now Chief of the Navy Research Section, Library of Congress. Mr. Martens is with the Technical Information Service, Atomic Energy Commission.

The Meaning of Relativity. 3rd Ed. Albert Einstein. Princeton, N.J., Princeton University Press, 1950. 164 pp. $2.50.

This book was first published in 1922. A second edition appeared in 1945. The present edition includes the Generalized Theory of Gravitation, attempting to interrelate all known physical phenomena. The original translated text, covering the special and general theories, remains unchanged.

STRUCTURES

Elasticity; Proceedings of Symposia in Applied Mathematics. Vol. III. (American Mathematical Society.) New York, McGraw-Hill Book Company, Inc., 1950. 233 pp., diagrs. $6.00.

Contents: Approximate Methods of Solution of Two-Dimensional Problems in Anisotropic Elasticity, I. S. Sokolnikoff. Beams Under Concentrated Loading, G. E. Hay. On Axisymmetrical Deformations of Thin Shells of Revolutions, Eric Reissner. On Asymptotic Integration in Shell Theory, F. B. Hildebrand. Some Recent Applications of the Theory of Finite Elastic Deformation, B. R. Seth. Elastic Stability of the Facings of Sandwich Columns, H. W. March. Dynamic Loads on Thin Plates on Elastic Foundations, D. L. Holl. Kirchhoff's Boundary Conditions and the Edge Effect for Elastic Plates, K. O. Friedrichs. Some Problems in the Bending of Thin Plates, G. F. Carrier and F. S. Shaw. Prestressing a Plane Circular Plate to Stiffen It Against Buckling (Abstract), J. J. Stoker. The Bending of Thin Elliptic Plates, C. L. Perry. New Methods for the Estimation of Torsional Rigidity, Alexander Weinstein. Stress Fields of Axially Symmetric Shafts in Torsion and Related Fields, H. Poritsky. Stress Analysis in Elastic-Plastic Structures, W. Prager and P. S. Symonds. Elastic-Plastic Straining (Abstract), Richard Southwell. A Graphical Method for Solving Problems in Plane Plasticity, N. Coburn. On Stress Discontinuities in Plane Plastic Flow, E. H. Lee.

Important Notice to Industrial Organizations from the U.S. Atomic Energy Commission

Industrial organizations interested in obtaining special training in Nuclear Reactor Technology for experienced engineers in their employ are invited to sponsor their enrollment in the 1951–1952 Session of the Oak Ridge School of Reactor Technology.

The deadline for experienced engineer applicants is April 1, 1951, and the school term begins September 10, 1951.

Established in 1949 at the Oak Ridge National Laboratory, the school operates a 12-month session open to two categories of engineering candidates. A limited number of recent college graduates are accepted in category A in the status of student employees. (Such applications must be received by March 1, 1951.) Category B students are selected from the applications sponsored by Government agencies and private industrial firms interested in participating in the A.E.C. National Nuclear Energy Program.

Such firms need not be connected with the A.E.C. currently.

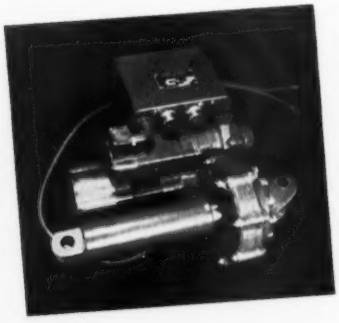
Officials of the Oak Ridge Reactor School point out that the majority of problems encountered in the field of nuclear engineering involve the same fundamental engineering and management skills common to industry generally. This school offers an unparalleled opportunity for experienced engineers to obtain a thorough understanding of the specialized problems the A.E.C. deals with in its nuclear engineering program. Trainees remain on the payrolls of their home organizations and, upon returning after completion of the course, can be expected to help strengthen their companies' positions to participate in the National Atomic Energy Program.

Further information and application forms may be obtained by writing to the Director, Oak Ridge School of Reactor Technology, P.O. Box P, Oak Ridge, Tenn.

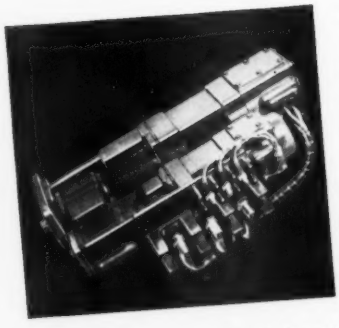
Since much of the material presented in the curriculum of the Oak Ridge School of Reactor Technology will be classified, all enrollments are contigent upon a personal security investigation. Announcements of appointments will be in April.

EEMCO technical bulletin

New Electric Power Units Foretell Era of Pushbutton Flight... Faster aircraft and busier pilots are pushing automatic flight devices into the forefront. The development of versatile fool-proof power units to actuate control surfaces in conjunction with automatic pilots is a primary factor in achieving pushbutton flight. Such units are being produced by EEMCO in close cooperation with the designers and builders of tomorrow's aircraft.



Stabilizer Actuator for Large Jet Fighters... One such "radical" advance is the motor actuator used on a new jet fighter. This unit incorporates two motors of different size, driving into individual gear reductions to operate the screw jack. Each fulfills a particular need and is not to be considered a standby. The small motor of 1/10 h.p. output operates practically continuously under control of the automatic pilot and provides a rate of travel to jack of 6/100" per sec. The large intermittent duty 3.3 h.p. motor provides manual operation of screw jack by pilot for maneuvering and extreme situations with a rate of travel of 7/10" per sec. Normal operating load of unit 11,000 lbs....28 volt operation. Equipment includes overload and travel limit switches, radio noise filters, position indicator and non-jamming stops.



Double Motor Power Unit for Horizontal Stabilizer... A similarly unconventional motor arrangement operates the horizontal stabilizer actuator on a turbo-prop aircraft of recent design. A small continuous duty motor of 1/15th h.p. operating through a gear reduction is used for automatic flight and a large intermittent duty 3-1/2 h.p. with direct drive of 12,000 rpm is used for manual operation. The unique feature again is that it provides a large power source for maneuvering and a smaller unit for trimming in flight in small increments through the automatic pilot.

EEMCO Design and Testing Service Solves Difficult Actuator and Motor Design Problems... Tell us your requirements on current motor or actuator design problems. Include preliminary data on type of unit, specific function, special requirements, operating conditions, motor and actuator specifications and any available drawings, diagrams and tables.

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I.A.S. Sections

(*Continued from page 27*)

The Ordnance Aerophysics Laboratory consists of three principal test units: (1) a large supersonic wind tunnel; (2) a burner facility for testing ramjets and other similar power plants; and (3) a high-altitude research unit. Complete engineering and shop facilities are maintained at the plant to execute and implement every phase of the operation of the facility.

The laboratory is a Naval Bureau of Ordnance facility and is operated for the Bureau by Convair under contract. It is located at Daingerfield, Tex., on grounds occupied by the Lone Star Steel Corporation and derives its power and air supply from that company's reserves.

Mr. Arnold's talk was illustrated by slides showing the location of the laboratory, living accommodations for the supervisory personnel, and operation of some of the components, including schlieren and spark photographs from the supersonic wind tunnel.

Mr. Arnold was introduced by K. E. Ward, Assistant Chief of Aerodynamics, Convair, and I.A.S. Area Councilor.

Texas Section

Russell E. Berger, *Secretary*

The December 13 meeting, held at the American Legion Hall in Grand Prairie, Tex., had the dual purpose of electing new officers and presenting an informative paper, "Design for Economic Producibility," by Robert H. Lundberg.

Chairman W. Andrew Pitman conducted the elections for officers and advisory board members. The newly elected officers are: Chairman, Edward Kurzawa, Consolidated Vultee Aircraft Corporation; Vice-Chairman, Paul Alberti, Chance Vought Aircraft Division, United Aircraft Corporation; Secretary, Roland Christy, Chance Vought; Treasurer, Russell E. Berger, Chance Vought.

Following the elections, Robert H. Lundberg, of Chance Vought, presented his address, effectively describing the engineering role in reducing cost while maintaining a top-quality product in a highly competitive market. Charts and graphs were presented to illustrate the causes of increased costs and their remedies. A booklet *Cost Tip Sheet*, containing valuable reference material, was distributed to each one in attendance.

Wichita Section

Melvin H. Snyder, Jr., *Secretary*

Lieutenant Colonel O. F. (Dick) Lassiter, Deputy Commander, B-47 Evaluation Program (Operation Wibac), spoke at the December 7 meeting on the subject, "Long Range Missions of the B-29."

Colonel Lassiter is currently the holder of the speed record over a 10,000-km. course and of the world's long-distance record (without refueling). He described the preparation for, and the flying of, these long missions in the "Pacusan Dreamboat." He also described the planning and execution of a round-the-world nonstop flight for which he served as Project Officer.

Calibration of engines and manual learning in flight as practiced during these missions were explained. Although Colonel Lassiter is currently in charge of the B-47 requirements, he described his "ideal" bomber as having extreme range capacity, large span, high aspect ratio, and extremely high ceiling. He stated that he believed that the bombers' protection lies not in speed but in maneuverability at high altitudes.

The dinner meeting was presided over by Chairman Doug Heimburger; 39 members were present.

Student Branches

California State Polytechnic College

Twenty-nine members and five guests attended the November 30 meeting at which Chairman Milo V. Price presided. R. K. Richardson, Assistant to Charles Alexander, Project Engineer, Induction Air Blast Facilities, Naval Air Missile Test Center, Pt. Mugu, Calif., told of the progress of various other graduates from California State Polytechnic College in the aircraft industry. He was followed by Mr. Alexander, himself, who spoke on "Testing Methods for Ram-Jet and Pulse-Jet Engines."

Clarkson College of Technology

Donald R. Wyeth, a sophomore in Clarkson's Mechanical Engineering Department, gave a "Comparison of the B-24 Liberator and the PB4Y Privateer" at the December 6 meeting. Vice-Chairman Louis Manno presided; 21 persons attended.

University of Florida

Chairman Costa Francisco led the November 7 meeting at which Robert L. Vandillen, Traffic and Sales Representative, Eastern Air Lines, Inc., delivered a few brief remarks about the film, *The Flying Fisherman*. Following the showing of this film, another, called *Operation Airborne*, was screened. Twenty persons were in attendance.

On December 5, John J. Tigert, Superintendent of Aircraft Components, Overhaul Section, Pan American World Airways, Inc., spoke on "Current Problems in Air Transport." Chairman Francisco presided; 20 persons attended.

University of Illinois

Vice-Chairman Loren Anderson presided at the December 6 meeting at which a film, *The P-47*, was shown.

The Johns Hopkins University

An organizational meeting was held recently at which the following officers were elected: Chairman, Gilbert Melese; Vice-Chairman, Donald Johnson; Secretary, Allen Kistler; and Faculty Sponsor, G. L. Bryan.

This branch is planning to combine its meetings with those of the Baltimore Section of the I.A.S.

Massachusetts Institute of Technology

A student seminar on "Pathfinders of Aviation" was sponsored by the Student Branch on November 14. Principal talks were given by Charles Ellis, Myron Hoffman, and Bob Wedan, who spoke on Lanchester, Cayley, and Lilienthal, respectively. A general group discussion followed. About 20 persons, including some of the faculty, attended.

The November 30 meeting was led by Chairman Henry R. Jex. The speaker was an M.I.T. student, Frank E. Mamrol, Jr., who gave a talk on "Helicopters." A film showed various miscellaneous views of Piasecki helicopters. Twenty-six persons attended.

University of Michigan

The officers elected at the meeting of October 11 are: Chairman, William Diener; Vice-Chairman, Gerald Vroman; Secretary, Jess Nourse; and Treasurer, Sydney Shrage. Professor J. D. Schetzer was selected to be the Honorary Chairman.

Richard Morrison, Aeronautical Research Center, University of Michigan, was guest speaker at the October 25 meeting. The subject of his talk was "Aeronautical Research Techniques."

The Student Branch attended the November 30 meeting of the I.A.S. Detroit Section. Major Jones, of Selfridge Field, spoke on the F-86.

About 50 Student Members traveled to Cleveland on December 19 to tour the facilities of the N.A.C.A. laboratories and to attend the Wright Brothers' Lecture. The tour of the laboratories was a successful one, and the guide, Mr. Hunter, was highly informative in his

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explanation of proceedings. The tour included the altitude test cells, the variable-density wind tunnel, the 8- by 6-ft. supersonic tunnel, and test setups. The climax of the trip was the Wright Brothers' Lecture given by Dr. William Bollay.

The University of Oklahoma

A joint meeting was held on December 13 with Tau Omega. Speaker at the meeting was Joseph E. Coulter, Chairman, Department of Aviation, and Manager, Max Westheimer Field, University of Oklahoma, who spoke on "C.A.A. Regulations." During his talk, Mr. Coulter showed a film entitled *A Plane Is Born*. Chairman Harold G. Coles, Jr., presided; 30 persons attended.

Because both the Chairman and Vice-Chairman were being graduated, a special election was held. Marinus A. Romano was elected Chairman and George C. Carver was elected Vice-Chairman; Messrs. Romano and Carver took office in January.

Polytechnic Institute of Brooklyn

A new secretary was elected at the October 31 meeting. This makes this year's list of officers as follows: Chairman, Thomas Denninger; Vice-Chairman, Thaddeus Kaplita; Treasurer, Basil Vafakos; and Secretary, Thomas Donohue. Chairman Denninger presided; 50 persons were present.

At the November 14 meeting, Dr. Nicholas J. Hoff, Head, Department of Aeronautical Engineering and Applied Mechanics, P.I.B., gave an illustrated lecture on "Aircraft Structural Design: Past and Future." Sixty persons attended; Chairman Denninger presided.

Riddle-McKay College of Aeronautics

New officers who officially took office in January were elected at the November 29 meeting as follows: Chairman, R. E. Frazer; Vice-Chairman, G. Guerrerro; Secretary, E. L. Krout; and Treasurer, J. D. Williams. Chairman Joseph W. Justin presided; 26 persons attended.

On December 5, films were presented in a new theater that was constructed by the I.A.S. Student Branch members with materials supplied by the school. The Branch has its own motion picture projector that was purchased with Branch funds. The films shown included *Unfinished Rainbows* and *Curiosity Shop*, which were obtained through the courtesy of the Aluminum Company of America. Chairman Justin presided.

Shell Oil Company film on *How an Airplane Flies* was shown on December 7. Chairman Justin presided.

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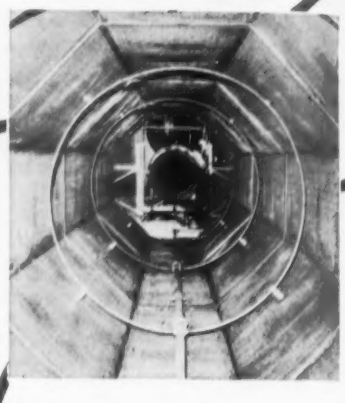

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Syracuse University

Chairman George Schmanke opened the January 10 meeting at which the results of an election of officers were announced as follows: Chairman, Hurlbut Horn; Vice Chairman, Thomas Egan; Secretary, Alan Robertson; and Treasurer, Jack Andrews. A film, *The ABC of G*, was shown.

University of Tulsa

At the December 14 meeting, Chairman John Beadling introduced the principal speaker, Benjamin Schladenhauffen, Chief Engineer—Engines, Repair Depot, American Airlines, Inc. After Mr. Schladenhauffen's talk on "Aircraft Engine Development by the Air Lines," two films, *Power by Wright* and *Faster than Sound*, were shown. Twenty-one persons attended.

U.S.A.F. Institute of Technology

At the December 13 meeting, Major Blue, Student Chairman, introduced Dr. G. R. Graetzer, Faculty Adviser and Departmental Head of Aeronautical Engineering, and Dr. Ezra Kotcher, Chairman of the Dayton Section and Director, U.S.A.F. Institute of Technology. Doctors Graetzer and Kotcher welcomed the new student members.

Captain Randall W. Briggs, Aero Medical Laboratory, Wright-Patterson Air Force Base, was guest speaker. His talk on the recent research activities in the Aero Medical Laboratory included "High-Altitude Flight," "High-Altitude Drop Tests," "Acceleration and Deceleration Tests," etc. Aero Medical Laboratory's latest classified film, *Special Projects of the Aero Medical Laboratory*, was shown.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Elected to Associate Fellow Grade

Hootman, James A., Ph.D., Assistant Chief, Research Administration Div., Headquarters Office, N.A.C.A. (Washington, D.C.).

Powers, E. M., Vice-President for Engineering, Curtiss-Wright Corporation.

Transferred to Associate Fellow Grade

Benford, Robert J., M.D.; Col., Air Surgeon, U.S.A.F. Research & Development Command, U.S.A.F., Washington, D.C.

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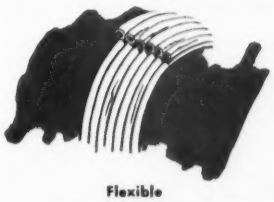

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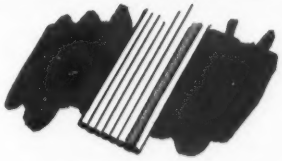

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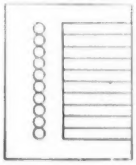

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Brising, Lars H., M.S. in Ae.E., Chief Engineer, Head of Airplane Design & Development Dept., SAAB Aircraft Co. (Sweden).

Kaganov, Benjamin J., M. of Ae.E., Chief Structures Engineer, Canadair, Ltd.

Razak, Kenneth, M.M.E., Dean of College of Business & Industry, School of Engineering, University of Wichita.

Vanik, Milford F., B.S.E. (Aero.), Staff Engineer (Airworthiness), Boeing Airplane Co. (Seattle).

Elected to MEMBER Grade

Barry, Frank W., Sc.D., Aerodynamicist, Aerophysics. Lab., Internal Aerodynamics Section, North American Aviation, Inc.

Chang, Chieh-Chien, Ph.D., Assoc. Prof. of Aero., The Johns Hopkins University.

Craft, James W., B.S. (Engineering), Administrative Asst., Pan American World Airways, Inc.

Maas, Stanley, B.M.E., President & Chief Engineer, Stanpat Co.

Mitrovich, Milenko, M.Ae.E., Chief Engineer, Regent Aircraft Corp.

Moore, Raymond J., Design Engineer, Northrop Aircraft, Inc.

Ritter, Arnold, M.S., Technical Consultant, Wright-Patterson Air Force Base.

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Transferred to MEMBER Grade

Adise, Herbert H., M. of Ae.E., Dynamicist, Reeves Instrument Corp.

Baker, Ralph D., Ph.D. in Ae.E., Prof. of Aero. Engineering, University of Utah.

Berry, David F., B.S. in Ae.E., Engineer—Project, Structural Test Group, Boeing Airplane Co. (Wichita).

Conner, D. William, B.S.M.E., Aero. Research Scientist, Langley Aero. Lab., N.A.C.A.

Coyle, James J., M.S. in Ae.E., Lt. Comdr., U.S.N.; Project Officer, Guided Missiles Div., Bureau of Aeronautics, Dept. of the Navy.

Engel, William N., B.S. in Ae.E., Chief Aircraft Engineer, Midwest Tool & Engineering Co.

Fischbach, Joseph W., M. of Ae.E., Ordnance Engineer, Ballistics Research Lab.

Hubbard, Herbert B., B.S. in Ae.E., Aero. Engineer "B," United Air Lines, Inc.

Kahn, Marvin J., M. of Ae.E., Structures Engineer, Republic Aviation Corp.

Leone, William C., M.S., Instructor in Mechanical Engineering, Carnegie Institute of Technology.

Liu, Tung-Sheng, M.S. in Ae.E., Instructor in Aero. Engineering & Asst. Research Scientist, The Aero. Engineering Research Lab., University of Minnesota.

Myers, Joseph R., M.S. in Ae.E., Capt. U.S.A.F.; Exchange Officer with R.A.F., Royal Aircraft Establishment (England).

Stevens, John E., M.S. in Ae.E., Sr. Analytical Project Engineer, Chance Vought Aircraft Div., United Aircraft Corp. (Dallas).

Wickham, Charles G., M.S. in Ae.E., Stress Analyst, Douglas Aircraft Co., Inc. (El Segundo).

Zubkoff, Maurice J., B.M.E., Assoc. Research Engineer, Cornell Aero. Lab., Inc.

Elected to Associate Member Grade

Henkel, Edward E., Public Relations Dir., Fairchild Engine & Airplane Corp.

Mangold, Elmer F., Asst. Secretary and Dir. of Purchases, Aircraft Div., The Globe Corp.

Transferred to Associate Member Grade

Chapman, Charles Anthony, B.Sc.

Elected to Technical Member Grade

Goldstein, David N., M.S. in Engrg., Technical Engineer, General Electric Co. (Lynn).

Hastings, Brian T., B.A.E., Lt. & Pilot, U.S.A.F.; Aero. Project Engineer, Computation Section, Office of Air Research, Hdqs., Air Materiel Command, Wright-Patterson Air Force Base.

Rastiello, Michael K., B.S. in Ae.E., Designer "B," assigned to the Lockheed Aircraft Corp., Machine & Tool Design Co.

Reece, Marvin P., A.A., Engineer, Rosan, Inc.

Savo, Charles E., ADC, Asst. to Airplane Engines Officer, Engineering Div. of the Staff, Comdr. Air Force, Pacific Fleet, Naval Air Station, San Diego.

Sevelson, Maurice S., Design Engineer, Personal Aircraft Research Centre, A. & M. College of Texas.

St.-Dobrzanski, Janusz, B.Sc., Aerodynamicist, A. V. Roe Canada Ltd.

Transferred to Technical Member Grade

Acampora, Andrew, B.S.Ae.E., Technical Writer "A," Service Engineering Dept., Douglas Aircraft Co., Inc. (El Segundo).

Aicher, Paul J., Jr., B.S., Sales Engineering Trainee, The Beryllium Corp.

Alexander, William G., B.S.E. (Aero.), 1st Lt., U.S.A.F.; Design & Development Officer, Engineering Div., Propeller Lab., Hdqs., Air Materiel Command, Wright-Patterson Air Force Base.

Anderson, Charles M., B.A.E., Flight Test Analyst "A," Lockheed Aircraft Corp.

Apte, Stanley H., B.Ae.E., Ordnance Engineer GS-5, War Dept., Picatinny Arsenal (Dover, N.J.).

Babowicz, John S., Public Information & Relations Officer, Civil Air Patrol.

Barnes, O. Garland, Jr., B.M.E. (Aero.), Graduate Student & Part-time Instructor, Applied Mechanics Dept., Virginia Polytechnic Institute.

Bath, George W., Draftsman, A. V. Roe Canada Ltd.

Blosser, Earl G., A.A., Aerodynamics Instructor, Spartan School of Aeronautics.

Blossom, John W., B.S. in Ae.E., Engineer, Joy Mfg. Co.

Bodofsky, Walter, B.S. (Aero.), Jr. Engineer, Piasecki Helicopter Corp.

Braden, James S., B.A., Major & Asst. Chief, Supply Control Div., U.S.A.F.

Caldwell, Joseph M.

Chaney, Raymond L., B.S.M.E. (Aero.), 1st Lt., Army Aviator & Aircraft Engineering Officer, U.S.A.

Cline, Gould L., B.S., B.A., 1st Lt. & Navigator (Radar), U.S.A.F.

Doukas, William A., Engineering Draftsman, Ryan Aero. Co.

Eggers, Richard J., Engineering Draftsman "B," Detail Group, Northrop Aircraft, Inc.

Eppinger, Roy W., A.A. in Ae.E., Design Engineer, Goodyear Aircraft Corp.

Eslinger, John J., B.S.M.E. (Aero.), Stress Analyst "A," Aerophysics Lab., North American Aviation, Inc.

Fabian, George, Engineering Draftsman, Hughes Aircraft Co.

Finney, Raymond, B.S.Ae.E., Jr. Engineer, Mechanical Engineering Section, Canadair, Ltd.

Gass, Robert C., B. of Engineering (M.E.), Senior Engineer—Experimental, TAPCO Div., Thompson Products, Inc.

Goldin, Milton.

Hall, Robert W., B. of Ae.E., Test Engineer, Combustion Development Section, General Electric Co.

Hayes, Roscoe C., Jr., Master Layout, Douglas Aircraft Co., Inc. (El Segundo).

Holder, Raphael A., B.S. in Ae.E., Aircraft & Engine Mechanic, U.S.A.F.

Howard, Robert R., B.S.A.E., Engineering Draftsman, Douglas Aircraft Co., Inc. (Long Beach).

Jacobson, J. Leonard, Jr., Engineer "B," Boeing Airplane Co. (Seattle).

James, Jack W., B.S.M.E. (Aero.), Draftsman "B," Preliminary Design, Douglas Aircraft Co., Inc. (Santa Monica).

Johnson, Warren C., B.S. in Ae.E., Engineering Trainee, Beech Aircraft Corp.

Jordan, Paul K., B.S., Engineering Expediter, General Electric Co.

Kemper, Robert G., B.S., Loftsman, Cessna Aircraft Co.

Klein, Frederick W., III, B.S.Ae.E., Jr. Engineer, Boeing Airplane Co. (Seattle).

Knudsen, Hans G., M.S. in Ae.E., Lt. & Station Education Officer, Royal Norwegian Air Force (Sola Airport).

Kramp, Harry F., B.S. in Ae.E., Engineer, Eighth Air Depot, Inc. (Sebring, Fla.).

Laxton, Eugene F., Engineering Asst. Stress "A," Northrop Aircraft, Inc.

Mancuso, Dewey J., B.S.

Mangan, John G., B.S., Field Service Engineer, Minneapolis-Honeywell Regulator Co.

Markula, Donald O., B.S.Ae.E., Engineering Draftsman, The Glenn L. Martin Co.

McDonald, Albert J., B.S.Ae.E. (Structures & Design).

McInnis, Albert K., Jr., B.S., Lt., Weather Officer & Pilot, U.S.A.F.

Miller, Glenn C., B.S. in Ae.E., Engineer GS-5, Wright-Patterson Air Force Base.

Mixon, Marvin S., M.S.A.E., Aerodynamicist, Douglas Aircraft Co., Inc. (Santa Monica).

Mooradian, Archie, Sgt., U.S.A.F.R.

Park, William E., B.S.M.E. (Aero.), Engineering Draftsman "A," Douglas Aircraft Co., Inc. (Santa Monica).

Peebles, Dewaine W., B.Ae.E., Design Engineer, Airframe Section, North American Aviation, Inc.

Pennypacker, William S., Pilot Training, U.S. Naval Air Cadets.

Plunder, Frank, Jr.

Poppe, William J., Weight Engineer, Douglas Aircraft Co., Inc. (Santa Monica).

Poterack, Raymond E., B.S.Ae.E., Technical Analyst, Flight Test, McDonnell Aircraft Corp.

Rehrmann, Robert J., B.S.Ae.E., Engineer, Aviation Gas Turbine Div., Westinghouse Electric Corp.

Rodgers, Edward J., B.S.E.

Roed, Aage E., B.Ae.E.

Rogers, Don E., M.S.Ae.E., Flight Test Analyst "A," Douglas Aircraft Co., Inc. (Santa Monica).

Rogers, Kenneth H., S.B., S.M., Design Engineer, Aerophysics Lab., North American Aviation, Inc.

Savelle, William M., B.S.

Schnebly, F. David, B.E. in Ae.E., Stress Analyst "A," United Helicopters, Inc.

Sciabbarrasi, Sebastiano A., Capt., U.S.A.F.

Simpkins, Donald W., Template Maker, Chance Vought Aircraft Div., United Aircraft Corp. (Dallas).

Sokolowski, Chester T.

Spee, Karl J., B.S.A.E., Jr. Design Engineer, Boeing Airplane Co. (Seattle).

Swope, Robert S., Research Engineer, Rotor-Craft Corp.

Taxter, James J., Detail Designer, Piasecki Helicopter Corp.

van der Wal, Franki L., B.S., Servomechanisms Engineer, Douglas Aircraft Co., Inc. (Santa Monica).

Van De Walker, Ray A., Engineering Draftsman "B," North American Aviation, Inc.

Wakefield, Fancher B., B.S. in Ae.E., Jr. Engineer, Piasecki Helicopter Corp.

Washburn, Richard O., Section Manager, Stress Dept., Northrop Aircraft, Inc.

Wilson, Edward S., B.A.E., Capt., U.S.A.F.; currently assigned as Student, Oak Ridge School of Reactor Technology.

Wilson, Paul D., Jr., B.S. in A.E., Jr. Engineer, Consolidated Vultee Aircraft Corp. (Ft. Worth).

Wood, Cleo B., B.S., Lt. (j.g.) and Naval Aviator, U.S.N.

Wright, Robert H., B.Ae.E. & M.S., Tool & Machinery Design Engineer, Ordnance Dept., Iowa Ordnance Plant.

Yindra, Joseph, B.S.E., Jr. Engineer, Westinghouse Electric Corp.

Zelibor, Marvin H., M.E. (Aero.), 2nd Lt., U.S.M.C.

The Engineering Approach

(*Continued from page 37*)

streetcar type of operation, where there are no schedules at all but a continuous flow of traffic. The present operation hindrances of aviation will all gradually be lifted. The extension of aircraft range is far transcending anything we have ever dreamed of, particularly when we presently enter the atomic-energy-engine era, which will succeed the jet-engine era. Safety will continue to be increased by better training, more reliable construction of aircraft and engines, and wonderful development of instrumentation.

What has not seemed to improve is the constantly increasing expense that is involved in the development of aircraft and their components. The expense of their usage also constantly grows, and we do not seem to be able to call a halt on this. However, higher expense is not a detriment if higher enough value in operation is given at the same time.

This prodigious advance from the Wrights' original invention has wrought profound changes in the sociological and political conditions in the world.

From the political standpoint, one of the most significant new concepts comes from the change that the great increase in aircraft range has brought with it. This needs, today, a real reappraisal and re-examination (to cast aspersions on this last word is to thwart a search for truth).

Whereas we were accustomed for so many years to consider the range of aircraft as a matter of a few hundred miles, we now have range increased to a matter of many thousands of miles. This, coupled with increased speed, means that those thousands of miles are covered in a few hours. We in aviation, knowing how much greater ranges are still in prospect, are aware of the political implications—and acutely so, when we see defense situations developing in which the now out-of-date concept of needing bases for aircraft operation away from our shores is still given such precedence and importance. It is high time that the progress we in aviation are engaged in be realized by the foreign offices of European nations and of our own. The political thesis—that the United States cannot conduct a war from its carriers and its own shores and is lost without the aid of someone else's air bases—is being daily reduced in making sense by the able engineers who are still further extending the range of our aircraft. Happily for both our Allies and ourselves, we can already do much in war potential from our own home and territorial grounds.

Another political implication inherent in the development in which we are engaged in aviation is that of deadly surprise due to the high speeds now available and even greater speeds that will be available in the decade to come. War action by the air route will be dramatically swift and demands a much greater alertness and preparedness than we ever conceived of. This we do not have today.

Let us return to the straight thinking of the Wrights—to the practical facing of facts and to the realization that honest thinking is always the winner in a contest with progress. In this way only will we solve our present limitations and, in so doing, extend our horizons to the same degree in the next 40 years that we have so thrillingly done in the two generations just passed.

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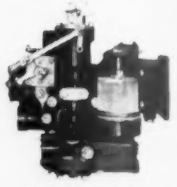
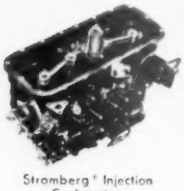


Fuel Metering Unit for jet engines



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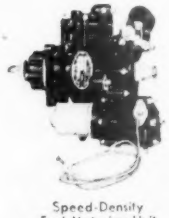

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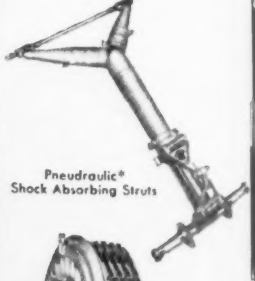

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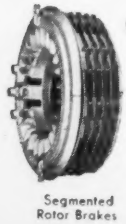

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Rocket-Model Men—Qualified wind-tunnel and rocket-model builders and designers are needed in a long-term program of dynamic rocket-powered free-flying models and missiles, along with wind-tunnel models, subsonic and supersonic. State all qualifications in first letter. Apply to Aerolab Development Company, 1922 Lincoln Ave., Pasadena 3, Calif.

Aircraft Engineers—Excellent openings for aircraft engineers in all major fields: Designers and Draftsmen, Structures Engineers, Stress Analysts, Aerodynamicists, etc. Also openings for recent college and technological engineering graduates. Long-range military program offers unusual opportunities. Please include summary of education and experience in reply to: Engineering Personnel Office, North American Aviation, Inc., Los Angeles International Airport, Los Angeles 45, Calif.

Preliminary Design Engineers—Thermodynamicist—Analytical investigations on turbines, compressors, pneumatic power systems, and related equipment. Should have background of thermodynamics, fluid dynamics, and heat transfer. **Vibration Engineer**—Analytical investigations on vibration of high-speed rotative equipment. Advanced mathematical training essential; **Air-Conditioning Engineer**—Engineering analyses and system proposals on aircraft air-conditioning systems. General background of heat transfer, fluid mechanics, and thermodynamics essential. **Technical Report Editor**—Edit engineering reports and specifications on aircraft accessory equipment. Must be engineering graduate with outstanding report organization and writing ability. Reply directly to AiResearch Manufacturing Company, Preliminary Design Engineering Department, 9851 Sepulveda Blvd., Los Angeles 45, Calif.

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Aeronautical, Electrical, Electronic, and Metallurgical Engineers and Aeronautical Draftsmen—The Naval Air Station, Corpus Christi, Tex., is seeking engineers in several fields for present needs and probable future needs. Applications are desired from personnel who have training and experience in the fields of engineering described below. Applications for the positions should be made on Standard Form 57 available at any first- or second-class post office and should be mailed to Industrial Relations Officer, Naval Air Station, Corpus Christi, Tex. **Aeronautical Engineer**—Development of assigned prototypes and pilot installations of recently developed equipment; preparation of reports; analysis of discrepancies toward the development of repair methods; and the development of testing and/or adjustment procedures for aircraft components and accessories. Two (2) positions, grade GS-9, at $4,600 per year are open for immediate needs. **Metallurgical Engineer**—To make physical and metallurgical tests of metals; perform chemical analyses for determination of type; prepare reports and memoranda; develop procedure for plating and cleaning of metals; and make analyses of plating and cleaning vat solutions. One (1) position, grade GS-9, at $4,600 per year is open for immediate needs. **Electrical and Electronic Engineers**—To develop prototypes and pilot installations of recently developed electrical and electronics equipment; evaluate and analyze resulting test data; prepare reports; analyze known discrepancies and design repair methods; and develop testing and adjusting procedures. **Engineering Draftsmen**—To make detail and installation drawings from prototype parts on installations; make sketches from the engineers' descriptions; and do art work on photographs for clarification and identification. Several positions, ranging from grade GS-4 at $2,875 per year to GS-7 at $3,825 per year, are proposed.

Engineers—The following vacancies for engineering personnel exist in the Bureau of Aeronautics, Department of the Navy, Washington, D.C.: **Aeronautical Engineers**—GS-11, $5,400 per annum. PP-65, conservation and substitution of critical materials; testing for prevention of engine corrosions; specifications and standards for power transmission devices and gearboxes. PP-61 developmental programs and correction of defects in aircraft starters and auxiliary power plants. PP-66, maintain continuous engineering appraisal of engines assigned, administer flight and laboratory tests, and take appropriate corrective action. PP-67, evaluate designs, administer ground and flight tests, and maintain technical administration of research and development contracts for ram-jet and pulse-jet engines. PP-59, assist in development, testing, and determination of operating limits for reciprocating and turboprop engines and individual components thereof. **Metallurgist**—GS-12, $6,400 per annum. Conceive, plan, and supervise research, investigation, and development work in the light alloys used in naval aircraft. **Aircraft Structural Loads Engineer**—GS-11, $5,400 per annum. Review and evaluate structural air-load reports, specify a series of structural flight tests, and investigate structural problems arising during development or testing of airplanes or guided missiles. **Mechanical Engineer**—GS-9, $4,600 per annum. Develop and improve existing equipment and review proposals for new catapult deck equipment such as equipment for handling, positioning, and securing aircraft. **Aircraft Preliminary Design Engineer**—GS-12, $6,400 per annum. Initiate and develop general designs of subsonic and supersonic land- and carrier-based piloted and pilotless planes. **Supervisory Chemical Engineer**—GS-13, $7,600 per annum. Initiate, supervise, and coordinate research and development projects directed toward new and improved solid and liquid rocket fuels and oxidizers. **Supervising Aeronautical Rocket Power-Plant Development Engineer**—GS-13, $7,600 per annum. Head of the Rocket Engine and Component Section Development Section, which initiates, supervises, and coordinates developmental projects of new and improved rocket engines and components. **Aeronautical Rocket Power-Plant Development Engineer (Installations)**—GS-12, $6,400 per annum. Head of the Guided Missiles Application Unit, which plans, initiates, and supervises the design, arrangement, and installation features of rocket-engine systems. **Materials Engineer**—GS-11, $5,400 per annum. Designs and improves pilots' clothing, parachutes, safety harnesses, survival equipment, life rafts, galley equipment, and related aircraft equipment. **Aeronautical Engineer**—GS-11, $5,400 per annum. Research, design, and development of power-boost and power-operated flight-control systems and components thereof. **Fire Control Design Engineer**—GS-11, $5,400 per annum. Assists project engineer in carrying out programs for the development of systems and components for the control of aircraft armament used in air-to-ground attacks. **Fire Control Design Engineers**—(2) GS-12, $6,400 per annum. Initiates and carries out programs for the complete development of systems and components for the control of aircraft armament. **Air Development Control Engineer**—GS-9, $4,600 per annum. Administer, coordinate, and execute projects of initial design, procurement, development, and testing of air-to-ship guided missiles. **Turret Design Engineer**—GS-11, $5,400 per annum. Performs administrative phase of research, development, and testing of aircraft turrets and turret components. Applicants submit Standard Form 57, application for Federal employment (available at any post office) to: Department of the Navy, Bureau of Aeronautics, Personnel Division, Attention: Aer-PE-22, 19th and Constitution Ave., N.W., Washington 25, D.C.

Development or Experimental Engineer—Graduate engineer with 5 years' experience in applied engineering, preferably in development. Familiar with turbojet engines. Mechanical design ability with background in thermodynamics and combustion. Capable of supervising development tests and writing good reports. Please direct reply to Solar Aircraft Company, 2200 Pacific Highway, San Diego 12, Calif.

Thermodynamicist—Graduate engineer to perform theoretical and design analysis of gas-turbine-type power plants. Must be analytical with practical realization of manufacturing problems. Background of thermodynamics, fluid dynamics, and heat transfer necessary. Five years' experience in applied engineering in these subjects. Must be capable of writing good reports. Please direct reply to Solar Aircraft Company, 2200 Pacific Highway, San Diego 12, Calif.

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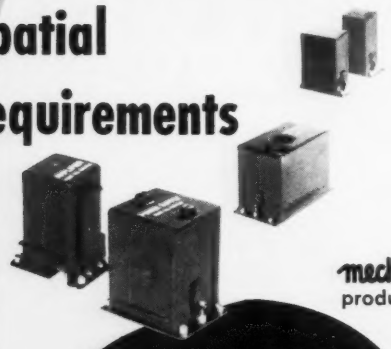

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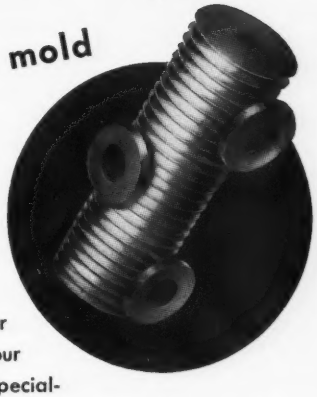

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262. Aeronautical Engineers—Eight years (1939–1947) with major airplane manufacturer as aerodynamicist and design engineer, embracing wind tunnel and flight testing in research and project work, airplane preliminary design, project chief aerodynamicist responsibility; some sales engineering with reference to military, commercial, jet-propelled, and flying-boat types of airplanes. Six years' total teaching experience; 4 years (1947 to present) as head of department, embracing applied aerodynamics and airplane design, in foreign technical institute. Some experience as consultant. N.Y.U. and M.I.T. Graduate School background. Age 35. Present contract expiring. Desires to relocate in U.S. or Canada. Receptive to propositions stressing opportunity rather than job security.

261. Mechanical Engineer—B.M.E., 1943. Experience of 6½ years in aircraft industry includes 5 years as aerodynamicist and 1½ years as lab analyst testing aircraft components and equipment. Desires position doing mechanical development test work. Location—Los Angeles area.

234. Teacher—Desires position as Assistant Professor or Associate Professor of Aeronautical Engineering or Engineering Mechanics at recognized college or university. B.Ae.E. degree, magna cum laude. M.S. in Ae.E. Three years of progressively responsible industrial experience, including stress analysis and design of tubular and stressed-skin structures and of the mechanical elements of civilian and military aircraft with emphasis in rotary-wing field. Over 4 years of college teaching experience as instructor and assistant professor. Qualified to teach graduate courses in theory of elasticity and elastic stability, experimental stress analysis, rotary-wing aerodynamics, etc., as well as undergraduate curriculum in aerodynamics, aircraft structures, and airplane design. In reply please discuss rank available and salary schedule.

Colorado University's Steam-Jet-Powered Supersonic Wind Tunnel

(*Continued from page 39*)

A schlieren photograph of one of the preliminary tests of flow past a single wedge at Mach Number of about 2 is shown in Fig. 6. The test section is 1.60 in. wide, and the height is 2.5 in. for a nozzle of $M = 3.01$ (1.61 in. for $M = 2.36$). The boundary layer on the lower surface (on which the model is mounted) in Fig. 6 is seen to be about ⅛ in., judging by the shock-wave reflections on the lower surface boundary layer. Fig. 7 is a similar photograph showing the flow past a cone.

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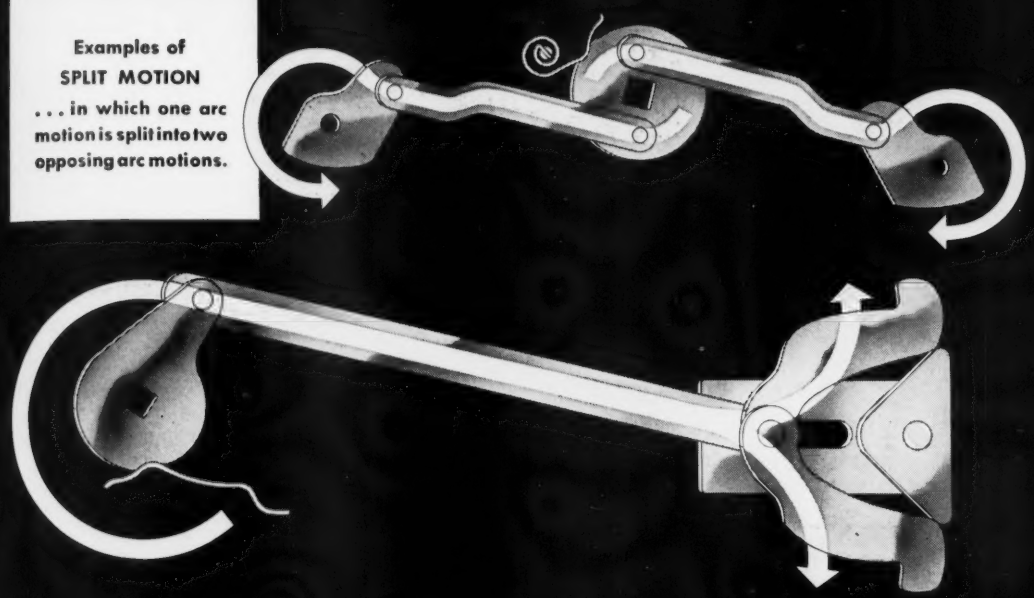

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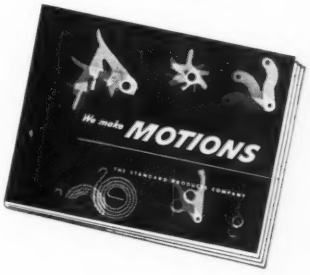

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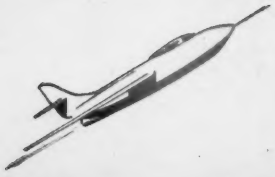
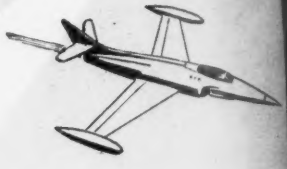


Ignition Headquarters



...for HIGH TENSION, LOW TENSION, HIGH FREQUENCY...JET or TURBO JET!

Bendix approaches each new ignition problem with an open mind. The particular type of ignition system to be recommended is decided upon solely on the basis of meeting individual requirements for economy, performance and dependability. Because of this completely objective and unbiased viewpoint, the aviation industry recognizes Bendix as the one source *uniquely qualified* to plan and produce ignition equipment to meet every operating condition.

No single type of ignition equipment is the final solution to every operating problem. Let Bendix experience help you determine the type of ignition equipment best fitted for your specific purposes.

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